General:

Each of the categories in the Clinical Curriculum is assumed to include the diagnosis and management of the problem for all etiologies to include atherosclerosis, trauma, infection, etc. where appropriate. A general understanding of each topic in the Clinical Curriculum is expected at the completion of vascular surgery training. In addition, the trainee is expected to know the natural history of the various diseases. Knowledge of additional/non-core topics will be encouraged but not required.

Educational objectives have also been developed for each section of the Clinical Curriculum. It is expected that these objectives will be achieved by each trainee at the completion of training. Included are selected references for each set of objectives that are suggested as minimal background reading for each section.
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Clinical Curriculum for Vascular Surgery

Educational Objectives

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1. **Diagnosis and Management of Aneurysmal Disease**

   Includes:

   - Aortic and Iliac Artery Aneurysms
   - Peripheral Artery Aneurysms
   - Extra-cranial Carotid Aneurysms
   - Subclavian/Axillary Artery Aneurysms
   - Femoral/Popliteal Artery Aneurysms
   - Splanchnic and Renal Artery Aneurysms
   - Thoracoabdominal Aortic Aneurysms
   - Thoracic Aortic Aneurysms
   - Thoracic/Abdominal Aortic Dissection

2. **Diagnosis and Management of Extremity Arterial Occlusive Disease**

   Includes:

   - Aortoiliac Occlusive Disease
   - Femoral-Popliteal-Tibial Occlusive Disease
   - Upper Extremity Occlusive Disease
   - Combined Aortoiliac and Infrainguinal Occlusive Disease
   - Arterial Bypass Graft Surveillance
   - Failing Arterial Bypass Graft
   - Ischemic Foot Lesions

3. **Diagnosis and Management of Renal Artery Occlusive Disease**

   Includes:

   - Renovascular Hypertension
   - Ischemic Nephropathy
   - Renal Artery Surgery
   - Renal Angioplasty
   - Diagnostic Studies to Detect Functionally Significant Renal Artery Stenosis

   Additional Important/None-Core Curriculum Topics:

   - Renal Arteriovenous Fistulae

4. **Diagnosis and Management of Visceral Ischemia**

   Includes:

   - Chronic Visceral Ischemia
Acute Visceral Ischemia
Non-Occlusive Mesenteric Ischemia
Mesenteric Venous Occlusive Disease

Additional Important/Non-Core Curriculum Topics:
Celiac/SMA Compression

5. **Diagnosis and Management of Carotid Artery Occlusive Disease**

Includes:
- Atherosclerotic Carotis Artery Disease
- Carotid Artery Fibromuscular Dysplasia
- Carotid Artery Coils and Kinks
- Carotid Artery Radiation Injury
- Carotid Body Tumor
- Overall Management of Stroke
- Spontaneous Carotid Artery Dissection
- Atherosclerotic Aortic Arch Disease Leading to Proximal Carotid Artery Stenosis

6. **Diagnosis and Management of Innominate, Subclavian and Vertebrabasilar Arterial Disease**

Includes:
- Stenotic and Embolic Innominate Artery Disease
- Stenotic and Embolic Vertebral Artery Disease
- Stenotic and Embolic Subclavian Artery Disease
- Subclavian Steal Syndrome

Additional Important/Non-Core Curriculum Topics:
- Vertebral Arteriovenous Fistulæ

7. **Diagnosis and Management of Thoracic Outlet Syndrome**

Includes:
- Cervical Rib/Abnormal First Rib
- Arterial Complications
- Venous Complications
- Neurogenic Complications

8. **Diagnosis and Management of Acute Arterial Occlusion**

Includes:
- Acute Thrombotic Disease
Atheroembolic Disease
Thromboembolectomy Techniques
Thrombolysis: Percutaneous & Intraoperative
Systemic Complications of Reperfusion Injury
Compartment Syndrome

9. Diagnosis and Management of Diabetic Foot Problems

Includes:

Pathophysiology of Ischemia, Neuropathy and Infection
Antibiotic Treatment
Amputation Types
Wound Management
Foot Care

Additional Important/Non-Core Curriculum Topics:

Orthotic Management

10. Diagnosis and Management of Complications of Vascular Therapy

Includes:

Pseudoaneurysms
Aortoenteric Fistulae/Erosions
Vascular Graft Infections
Colon Ischemia after Aortic Surgery
Chronic Perigraft Seromas
Occluded Prosthetic Grafts
Prosthetic Graft Dilation

11. Diagnosis and Management of Vascular Trauma

Includes:

Aortic Trauma
Carotid Trauma
Brachiocephalic Trauma
Visceral Arterial Trauma
Extremity Trauma
Venous Trauma
Diagnosis of Vascular Trauma - Arteriography/Duplex
Nonoperative Therapy
Traumatic A-V Fistulas
Iatrogenic Vascular Trauma

Additional Important/Non-Core Curriculum Topics:

Associated Neural Injury
12. **Diagnosis and Management of Venous Thromboembolic Disease**

Includes:

- Deep Venous Thrombosis
- Deep Venous Thrombosis Prophylaxis
- Pulmonary Emboli
- Caval Interruption
- Subclavian/Axillary Thrombosis
- Venous Thrombectomy/Thrombolytic Therapy
- Anticoagulation

Additional Important/Non-Core Curriculum Topics:

- Acute Caval Thrombosis Syndrome
- Pulmonary Embolectomy (open & catheter based)
- Renal Vein Thrombosis
- Budd-Chiari Syndrome

13. **Diagnosis and Management of Chronic Venous Insufficiency**

Includes:

- Noninvasive Diagnosis
- Medical Treatment
- Sclerotherapy
- Surgical Reconstruction including Subfascial Ligation of Perforators, Valvular Congenital Causes

14. **Diagnosis and Management of Lymphedema**

15. **Indications and Techniques for Extremity Amputation**

Includes:

- Determination of Amputation Level

Additional Important/Non-Core Curriculum Topics:

- Post-Amputation Care
- Prosthetic Management
- Rehabilitation
- Phantom Pain Symptoms

16. **Techniques for the Diagnosis of Peripheral Vascular Disease**

Includes:

- Hemodynamic Assessment of Arterial and Venous Disease
Duplex Evaluation of Carotid, Venous, Mesenteric, Renal and Extremity Vascular Disease
Arteriography
Computerized Tomography
MRI/MRA
Intraoperative Duplex Evaluation

Additional Important/Non-Core Curriculum Topics:

Intravascular Ultrasound

17. **Use of Endovascular Therapy in the Management of Peripheral Vascular Disease**

Includes:

Lytic Therapy
Balloon Angioplasty
Endoluminal Stents
Stent Grafts
Angioscopy
Endoluminal Ultrasound
Embolization

18. **Risk Stratification in Patients with Peripheral Vascular Disease**

Includes:

Cardiac Risk Evaluation
Pulmonary Risk Evaluation
Atherosclerotic Risk Factor Assessment
Lipid Disorder Evaluation and Management

19. **Diagnosis and Management of Coagulation Disorders in Patients with Peripheral Vascular Disease**

Includes:

Bleeding Disorders/Intraoperative Bleeding
Heparin Associated Thrombocytopenia
Hypercoagulable States
Low Molecular Weight Heparin
Antiplatelet Agents Including Ticlopidine

20. **Diagnosis and Management of Miscellaneous Vasculogenic Problems**

Includes:

Vasospastic Diseases
Neurogenic Thoracic Outlet Syndrome
Causalgia/Reflex Sympathetic Dystrophy
Additional Important/Non-Core Curriculum Topics:

Vasculogenic Impotence
Pediatric Vascular Disorders
Frostbite

21. Diagnosis and Management of Non-Atherosclerotic Vascular Diseases

Includes:

Systemic Vasculitis
  Giant Cell Arteritis
  Takayasu’s Disease
Radiation Induced Arterial Disease
Arterial Infections
Adventitial Cystic Disease
Popliteal Entrapment Syndrome
Buerger’s Disease
Congenital Problems
  Coarctation
  Persistent Sciatic Artery
  Aberrant Subclavian Artery
Arteriopathies
  Marfan’s Syndrome
  Ehlers-Danlos Syndrome
  Arterial Magna Syndrome
  Cystic Medical Necrosis
  Behcet’s Disease
Homocystinuria
Intra-Arterial Drug Induced Injury

22. Diagnosis and Management of Arterial Venous Malformations

Includes:

Surgical, Catheter and Nonoperative Management of Angiodysplasias

23. Indications for and Techniques of Vascular Access

Includes:

Vascular Access for Hemodialysis
Ischemic Hand After Vascular Access
Peripheral Dialysis Access

24. Indications for and Results of Sympathectomy in Patients with Peripheral Vascular Disease

25. Diagnosis and Management of Portal Hypertension
EDUCATIONAL OBJECTIVES

1. **Aneurysmal Disease**
   William H. Pearce, M.D., Christopher Zarins, M.D., John W. Hallett, M.D.

   **I. Basic Science**
   1. To describe aortic architecture and functions.
   2. To describe hemodynamic changes at major bifurcation and Laplace’s Law.
   3. To describe the role of aging and atherosclerosis in aortic enlargement.
   4. To describe the role of inflammation and proteases in aneurysm formation.
   5. To describe the differences in Marfan’s disease and Ehlers Danlos syndrome.

   **II. Diagnostic Evaluation**
   1. To understand the incidence and prevalence of aneurysmal disease according to age.
   2. To understand the natural history of abdominal aortic aneurysms.
   3. To understand the genetic distribution of the disease.
   4. To understand the roles of ultrasound, angiography, CT and MRI/MRA in screening and in planning surgery.

   **III. Treatment**
   1. To understand the indications for surgical repair and the factors which contribute to surgical decision making.
   2. To understand the technical aspects of aortic aneurysm repair and surgical options and alternatives.
   3. To describe the surgical management of complex aortic aneurysms (including horseshoe kidneys, aortocaval and aorto duodenal fistulae, mycotic, inflammatory).
   4. To have knowledge of both the immediate and long-term outcomes of surgery for aortic aneurysmal disease (including symptomatic, asymptomatic, thoracoabdominal, juxtarenal, infrarenal and recurrent).
   5. To describe the management and prevention of surgical complications including spinal cord ischemia, distal embolization, myocardial infarction, graft infection.

**References**
30. Katz KA, Cronenwett JL. The cost-effectiveness of early surgery versus watchful waiting in the...
Peripheral Vascular Occlusive Disease
Anthony D. Whittmore, M.D., James M. Seeger, M.D., Jon R. Cohen, M.D.

I. Anatomy & Pathophysiology
1. To define the normal arterial anatomy of the peripheral vascular system including commonly encountered anatomic variations.
2. To recognize the physiologic and pathophysiologic collateral circulatory routes which commonly develop in response to occlusive disease.
3. To understand the neural, humoral and pharmacologic mechanisms which affect peripheral vascular reactivity and auto-regulatory function.
4. To appreciate the multiple etiologies of acute peripheral vascular ischemia including embolism, thrombosis, dissection, venous occlusion, trauma.
5. To appreciate the multiple etiologies of chronic peripheral vascular ischemia including atherosclerosis, aneurysm, entrapment syndromes, trauma, and a variety of non-atherosclerotic occlusive entities.
6. To understand the mechanism of early and late graft failure, fibro-intimal hyperplasia and progression of disease.

II. Diagnostic Evaluation

Acute Peripheral Ischemia
1. To understand the signs and symptoms characteristic of acute arterial ischemia and the differential diagnosis.
2. To understand the importance of assessing the degree of acute ischemia.
3. To appreciate the significance of the duration of acute ischemia.
4. To recognize the importance of antecedent clinical entities which may predispose to acute peripheral ischemia including atrial fibrillation, prior myocardial infarction, aortic dissection and hypercoagulopathies.
5. To appreciate the significance of initial electrolyte, acid base and other laboratory parameters useful in assessing the magnitude of ischemia to define the indications for appropriate therapy.
6. To understand the relative indications for immediate diagnostic angiography versus urgent surgical exploration.
7. To understand the arteriographic findings characteristic of different etiologies and to appreciate the diagnostic imaging options available in addition to arteriography (MRA, CT, duplex imaging).

Chronic Peripheral Vascular Ischemia
1. To understand the characteristic signs and symptoms of chronic peripheral vascular ischemia relative to the patient’s history and physical examination.
2. To understand the importance of appropriate imaging studies prior to formulating a therapeutic management plan.
3. To understand the importance of hemodynamic testing in the formulation of a therapeutic management plan.
4. To appreciate the characteristic angiographic findings in patients with common patterns of peripheral vascular occlusion as well as the importance of assessing available collaterals.

III. Treatment

Acute Peripheral Vascular Ischemia
1. To appreciate the relative indications for immediate angiography, thrombolytic therapy, or urgent surgical exploration relative to the duration of symptoms and magnitude of ischemia.
2. To have a comprehensive understanding of the variety of surgical exposures of the peripheral vasculature.
3. To understand the relative indications for the major surgical options available for peripheral occlusive disease including endarterectomy, patch angioplasty and bypass graft (autogenous versus prosthetic).
4. To understand the role of intra-operative thrombolytic agents, dosage and mechanisms of action.
5. To appreciate the sequela of reperfusion following acute ischemia in terms of systemic effects as well as local effects warranting fasciotomy including the anatomy and physiology of fasciotomy.
6. To be familiar with endovascular options for the treatment of occlusive disease including atherectomy, laser, balloon angioplasty, stent graft, as well as the role of angioscopy.
7. To understand the importance of completion imaging studies following peripheral arterial reconstruction.

**Chronic Peripheral Vascular Ischemia**
1. To have a comprehensive understanding of all standard surgical approaches for surgical revascularization including endarterectomy, patch angioplasty and bypass (in-situ and reversed vein grafts, prosthetic grafts).
2. To understand the difference in application of options relative to the degree of ischemia (claudication versus critical ischemia, with or without tissue necrosis).
3. To understand indications for primary amputation.
4. To have an understanding of the role of endovascular approaches including laser, atherectomy, thrombectomy, balloon dilatation with or without stent, and angioscopy.
5. To have a comprehensive knowledge of popliteal entrapment and advential cystic disease and their treatment.
6. To understand the necessity for post revascularization non-invasive hemodynamic assessment and criteria for reintervention for a failing of failed bypass.

**References**
3. Renal Artery Disease
Kimberly J. Hansen, M.D., Robert G. Atnip, Jr., M.D., Gregorio A. Sicard, M.D.

I. Anatomy and Pathophysiology
1. To define normal renal artery anatomy and collateral pathways important in renal artery disease.
2. To understand the etiology, pathology and natural history of these renal artery lesions:
   a. Renal artery atherosclerosis
   b. Renal artery fibromuscular dysplasia
   c. Renal artery aneurysm
   d. Renal arteriovenous malformation
   e. Takayasu’s arteritis
   f. Middle aortic syndrome/congenital hypoplasia
   g. Atheroembolic disease
   h. Renal artery trauma
   i. Embolic occlusion
   j. Renal artery dissection
3. To define common co-existing extrarenal diseases associated with the various renal artery lesions.
4. To understand the exocrine and endocrine function of the kidney, and relate these to the structure and function of the nephron unit.
5. To understand the renin-angiotensin axis in the absence and presence of renal artery disease.
6. To describe the mechanisms of renovascular hypertension and renovascular insufficiency (i.e., ischemic nephropathy) and to understand how these differ for unilateral and bilateral renal artery disease.

II. Diagnostic Evaluation
Screening and Imaging
1. To describe the clinical features of renovascular hypertension and renovascular insufficiency, and to contrast these with essential hypertension and parenchymal renal failure.
2. To describe the performance and diagnostic criteria for these screening/imaging studies:
   a. Captopril renin test
   b. Captopril renography
   c. Intravenous urography
   d. Ultrasonography
      1. Duplex sonography
      2. Intravascular sonography
   e. Spiral computerized tomography
   f. Magnetic resonance imaging
   g. Angiography
      1. Digital subtraction angiography
         a. Intravenous
         b. Intra-arterial
      2. Cut-film angiography
      3. CO₂ angiography
3. To define the applications and limitations of available screening/imaging studies.

Tests of Functional Significance
1. To distinguish between functionally significant and clinically silent renal artery disease.
2. To define the selection and patient preparation for these studies of functional significance:
   a. Split renal function test
   b. Selective renal vein renin determination
   c. Peripheral plasma renin determination
d. Captopril renin test  
e. Captopril renography

3. To describe the diagnostic criteria, predictive value and limitations of each study of physiologic significance.

III. Treatment

1. To describe the strategies, options and anticipated results of medical management for the various renal artery lesions.
2. To appreciate the limitations and complications associated with medical management of renovascular hypertension and renovascular insufficiency.
3. To understand the indications, anticipated anatomic results and clinical response associated with catheter-based intervention for the various renal artery lesions:
   a. PTA ± intravascular stenting  
b. Atherectomy  
c. Fibrinolytic therapy
4. To understand the indications for surgical renal artery reconstruction as they relate to the various renal artery lesions.
5. To define the techniques of surgical exposure for renal artery lesions.
6. To understand the selection and performance of direct and indirect reconstruction for the different renal artery lesions:
   a. Direct reconstruction  
      1. Aortorenal bypass  
      2. Endarterectomy  
         a. Transaortic  
         b. Transrenal  
      3. Reimplantation  
      4. Ex vivo reconstruction  
   b. Indirect reconstruction  
      1. Splanchnorenal bypass  
         a. Splenorenal  
         b. Hepatorenal  
         c. Nephrectomy  
7. To describe the anticipated results of reconstruction and nephrectomy as they relate to hypertension response, renal function response, subsequent cardiovascular events and patient survival.
8. To define the management of silent and functionally significant renal artery lesions combined with occlusive or aneurysmal aortic disease.
9. To recognize and develop a plan of management for complications associated with surgical management of renal artery disease and understand how these complications relate to co-existing renal and extrarenal disease.

References
4. **Visceral Ischemia**  
William R. Flinn, M.D., Bruce L. Gewertz, M.D., Leonard P. Krajewski, M.D.

I. **Anatomy and Pathophysiology**
1. To define the normal arterial and venous anatomy of the mesenteric circulation and to be familiar with the more frequently encountered anatomic variations.
2. To recognize the physiologic and pathophysiologic collateral circulation to the gastrointestinal tract that may develop in response to occlusive disease of the main mesenteric vessels.
3. To understand the high flow, low resistance physiology of normal mesenteric blood flow, recognize the neural, humoral (hormonal) and enteric (intraluminal) mechanisms of autoregulation, and understand the high degree of vasoreactivity of this arterial bed.
4. To understand the multiple etiologies of acute mesenteric ischemia including embolism, thrombosis, dissection, venous occlusion, trauma, and gut ischemia following aortic reconstruction.
5. To understand the multiple possible etiologies of syndromes of chronic mesenteric ischemia including atherosclerosis, aneurysm, extrinsic compression syndromes, and other nonatherosclerotic arteriopathies.
6. To understand the clinical correlation of multiple visceral vessel involvement with the development of symptoms of chronic intestinal ischemia based upon an understanding of the compensatory collateral perfusion of the gut.

II. **Diagnostic Evaluation**

**Acute Mesenteric Ischemia**
1. To understand the characteristic initial signs and symptoms suggestive of acute mesenteric ischemia and how symptoms and physical findings may differ from other causes of the acute abdomen.
2. To define preexistent clinical conditions that may predispose to, or support the clinical diagnosis of acute mesenteric ischemia, e.g. atrial fibrillation, previous myocardial infarction (mesenteric embolism), severe cardiopulmonary dysfunction (non-occlusive ischemia), history of post-prandial pain and weight loss, known aortic dissection (mesenteric thrombosis), hypercoaguable states (mesenteric venous thrombosis).
3. To understand the parameters of initial serologic testing that characterize or may support the clinical diagnosis of acute mesenteric ischemia.
4. To define the indications for mesenteric arteriography (or other forms of visceral arterial imaging) in patients with suspected acute mesenteric ischemia and understand the technical aspects of the conduct of arteriography necessary to make an accurate diagnosis.
5. To define the characteristic arteriographic findings diagnostic of the major causes of acute mesenteric arterial ischemia; mesenteric thrombosis, mesenteric embolism, and non-occlusive mesenteric ischemia.
6. To define the appropriate diagnostic evaluation for suspected intestinal ischemia following aortic surgery.
7. To understand the usefulness of alternative imaging techniques (CT, MRI) for the diagnosis of acute mesenteric venous thrombosis.

**Chronic Mesenteric Ischemia**
1. To understand the characteristic signs and symptoms of chronic mesenteric ischemia and how other aspects of patients’ history (e.g. previous aortic surgery) or physical examination (e.g. aortoiliac occlusive disease) may suggest the presence of associated visceral arterial occlusive disease.
2. To understand the limitations of standard gastrointestinal diagnostic testing modalities (e.g. GI endoscopy, contrast studies, CT, etc.) for diagnosis of chronic mesenteric ischemia.
3. To understand the usefulness of porto-mesenteric duplex ultrasound scanning for elective noninvasive evaluation of the major visceral vessels.
4. To define the indications for arteriography (or alternative vascular imaging studies) in patients with suspected chronic mesenteric ischemia and understand the arteriographic findings that are considered diagnostic of this condition.
5. To recognize the characteristic arteriographic findings in atypical causes of mesenteric arterial compromise.
including extrinsic compression and nonatherosclerotic visceral arterial disease.

III. Treatment

Acute Mesenteric Ischemia

1. To be familiar with techniques for surgical exposure of the main mesenteric vessels, to understand standard surgical options for revascularization following acute mesenteric embolism or acute mesenteric arterial thrombosis, and to understand surgical options for the management of intestinal necrosis when this has occurred.

2. To recognize the relationship of different anatomic patterns of gut infarction to the different causes of acute mesenteric ischemia when intestinal infarction is encountered unexpectedly at the time of laparotomy.

3. To understand the critical relationships between the extent of viable bowel (before and/or after successful revascularization) and the extent of resection of nonviable intestine, and the impact of these observations upon both the short and long-term prognosis for the patient.

4. To understand the relative usefulness of intraoperative techniques available for the assessment of intestinal viability at the time of surgical treatment for acute mesenteric ischemia.

5. To understand the pathophysiologic effects of intestinal reperfusion after surgical treatment of acute mesenteric ischemia and the impact of these effects on postoperative patient care.

6. To understand the role of early empiric re-exploration following surgical treatment of acute mesenteric ischemia.

7. To understand standard and alternative treatments for mesenteric venous thrombosis including the role of surgical treatment in the management of this disorder.

8. To understand the management of suspected acute gut ischemia occurring after aortic surgery.

9. To understand the therapeutic role of interventional non-surgical treatments in the management of all forms acute mesenteric ischemia, particularly in non-occlusive mesenteric ischemia.

Chronic Mesenteric Ischemia

1. To be familiar with all standard surgical techniques for direct, elective visceral revascularization and understand the importance of comprehensive revascularization in the surgical treatment of chronic intestinal ischemia.

2. To be aware of surgical alternatives for treatment of atypical or non-atherosclerotic visceral arterial occlusive lesions.

3. To understand the possible application of interventional, nonsurgical treatments for chronic visceral arterial occlusive lesions.

4. To understand the usefulness of noninvasive vascular testing for the follow-up of patients having visceral revascularization procedures.

References


5. **Carotid Artery Disease**  
Alan M. Graham, M.D., Wesley S. Moore, M.D., William Baker, M.D.

I. Anatomy and Pathophysiology  
1. To describe the anatomy of the arch, great vessels, and intracranial arteries.  
2. To describe the embryology of the above and relate the common anomalies to the embryology.  
3. Discuss the collateral arterial communications of the extracranial and intracranial arteries.  
4. To discuss the diagnosis of anomalies and collateral circulation utilizing diagnostic modalities including CT scan, MRI, SPECT, and transcranial doppler.  
5. To understand the different etiologies of carotid artery disease.  
   a. Atherosclerosis  
      i. Define the systemic risk factors for atherosclerosis.  
      ii. Define the systemic effects of atherosclerosis and how these effects impact the diagnosis and treatment of the patient with carotid stenosis.  
   b. Kinking and tortuosity  
   c. Fibromuscular dysplasia  
   d. Compression  
   e. Traumatic occlusion  
   f. Acute Dissection  
   g. Inflammatory arteriopathies  
6. To describe the gross pathologic and histologic characteristics of each etiology above.  
7. To discuss how each etiology produces cerebral events in terms of occlusion and/or embolism.  
8. To discuss the normal flow patterns at the carotid bifurcation, and how they are affected by the atherosclerotic process.

II. Diagnostic Evaluation  
**History and Physical Examination**  
1. To define hemispheric, non-hemispheric, and non-specific symptoms.  
2. To differentiate among transient ischemic attack (TIA), reversible ischemic neurologic deficit (RIND), stroke in evolution and completed stroke.  
3. To describe the arterial and neurologic examination and their importance in caring for patients with carotid artery disease.  
4. To describe the relationship between carotid artery atherosclerosis and the clinical syndrome of vertebrobasilar insufficiency.  
5. To describe and defend the appropriate evaluation for patients with each of the above clinical presentations.

**Carotid Duplex Examination**  
1. To be able to explain the principles of doppler ultrasound.  
2. To describe the normal doppler signals in the internal, external, and common carotid arteries.  
3. To discuss the sensitivity and specificity of duplex scanning in detecting carotid artery stenosis.  
4. To discuss the risks and benefits of relying on duplex ultrasound and eliminating angiography.  
5. To understand the basics of P.V. Lab Accreditation.

**Angiography and MRA**  
1. Angiography: to be able to discuss the technique, its limitations and complications.  
2. MRA: to be able to discuss the technique, limitations and complications.  
3. To discuss and compare the different methods of measuring stenosis.
Diagnostic Brain Scanning
1. For each of the following modalities, explain the principles, indications, complications, and its influence upon the indications for carotid endarterectomy.
   a. CT scan
   b. MRI
   c. SPECT
   d. Transcranial doppler

III. Treatment
Treatment of Neurologic Syndromes in Patients with Carotid Stenosis
1. To discuss the non-surgical and surgical treatment of acute ischemic syndromes including stroke.
2. To discuss the role of thrombolytic therapy in the treatment of stroke syndrome.
3. To be able to construct a diagnostic and treatment algorithm for various stroke syndromes.
4. To be able to discuss the potential role of endovascular treatment.

Surgical Treatment
1. To discuss the intrathoracic and extrathoracic treatment of atherosclerotic stenosis or occlusion of the great vessels.
2. To describe the standard approach to carotid endarterectomy including intraoperative shunting, patching, anesthetic techniques, tacking sutures and methods of completion evaluation.
3. To describe the surgical treatment of fibromuscular dysplasia, kinking, radiation arteritis, tumors involving the carotid artery, other arteritides, and recurrent carotid stenosis.
4. To recognize the carotid sinus syndrome and discuss its treatment.
5. To discuss EC-IC bypass.
6. To discuss the indication and performance of proximal and distal vertebral artery reconstruction.

Complication of Carotid Endarterectomy
1. To describe the etiology and management of:
   a. Wound hematoma
   b. Wound infection
   c. Post-operative hyper and hypotension
   d. Peripheral nerve palsies
   e. Transient ischemic attack and stroke
   f. Asymptomatic thrombosis
   g. Intracranial hemorrhage
   h. Post-operative seizure
   i. Extracarotid (cardiac) events

References


6. **Innominate, Subclavian and Vertebrobasilar Arterial Disease**  
Ramon Berguer, M.D., Michael DaValle, M.D., Francis Robicsek, M.D.

I. **Etiology, Pathophysiology and History**
1. Pathophysiology of atherosclerosis, trauma, dissection, arteritis and radiation as it applies to the innominate, subclavian and vertebrobasilar arteries.
2. Concomitant diseases and associated risk factors commonly associated with stenosis, occlusion, dissection, ulcerated atheroma, arteriovenous fistula and false aneurysm of these arteries.
3. Define the most appropriate diagnostic steps for the evaluation and for the choice of treatment of these conditions.
4. Abnormal and alternative flow patterns that may develop as a consequence of lesions of the innominate, subclavian and vertebrobasilar arteries.
5. Best diagnostic methods available to assess end-organ effects in the brain and upper extremities of the lesions mentioned above.
6. Natural history of these conditions and how this natural history is affected by treatment methods when the latter are successful and when they fail.

II. **Diagnosis**
1. Symptoms and signs of brain ischemia in its various manifestations, localized and global, progressive and sudden.
2. Symptoms of ischemia of the upper extremity.
3. Signs of ischemia of the brain or upper extremities elicited by provocative maneuvers.
4. Understand the differential diagnosis of conditions that may present with similar signs or symptoms.
5. Understand how noninvasive tests may suggest or deny the presence of lesions of the innominate, subclavian and vertebrobasilar arteries and how these tests may preclude or indicate arteriography.
6. Understand the anatomy of these arteries and their lesions as defined by arteriography, the timing of films and the best projections to display them.
7. Know the risks involved in arteriography relative to the contrast agents used and their amount, the approach used and the pharmacologic and technical maneuvers employed.
8. Value and shortcomings of CT and MRA/MRI imaging techniques in the diagnosis of these entities.

III. **Treatment**
1. Options for (a) medical treatment (antiplatelet, anticoagulant, steroids, antiinflammatory drugs), (b) surgical repair whether direct (endarterectomy, transposition, ligation) indirect (bypass, decompression) or (c) endovascular (angioplasty, stenting, covered stents).
2. Indications for combined treatment and their timing.
3. Possible complications of each of the above treatments and their management.
4. Long-term results with the different treatment options.

**References**
7. **Thoracic Outlet Syndrome**
Jonathan B. Towne, M.D., John Corson, M.D., Irving Kron, M.D.

I. Anatomy and Pathophysiology
1. To understand the anatomy of the thoracic outlet to include anatomic variations in bones, muscles, and cervical ribs.
2. To recognize the origin of insertion of the musculoskeletal structures which surround the nerves and blood vessels that supply the arm.
3. To recognize the location of the costovertebral ligaments and the boundaries of the scalene triangle and the costoclavicular space.
4. To recognize the location and incidence of anatomic variations of the insertion of the cervical rib.
5. To recognize insertions of the anterior scalene and its relationship to the neurovascular structures.
6. To recognize the origin and insertion of the subclavius muscle and the possibility of encroaching the neurovascular structures in the costoclavicular triangle.
7. To recognize and define skeletal abnormalities, e.g. elongated C-7 transverse process, callous formation from a fractured clavicle or first rib, hypoplastic first rib, the anatomy of cervical nerves C-5, C-6, C-7, C-8, and T-1, and their relationships to the thoracic outlet.

II. Diagnostic Evaluation
1. To understand that pain is a principal symptom of neurologic type of thoracic outlet and that the distribution of pain which arises from the upper three nerves of the brachial plexus, C-5, C-6, and C-7, as distinct from the pattern of pain emanating from the lower nerves of the plexus, C-8 and T-1.
2. To recognize the arterial symptoms (embolization to hand and forearm, post stenotic dilatation, and subclavian artery occlusion) and venous symptoms (subclavian vein thrombosis for clinical diagnosis).
3. To understand this may present as spontaneous, related to injury (hyperextension, flexion injuries of the neck, blunt trauma), or that symptoms may occur with hyperadduction of the shoulder or arm exertion.
4. To define differential diagnoses of thoracic outlet to include cervical disc syndrome, carpal tunnel syndrome, orthopedic shoulder problems (shoulder sprain, rotator cuff injuries, tendonitis, cervical spondylitis, ulnar nerve compression at the elbow), Multiple Sclerosis, spinal cord tumor disease, angina pectoris, and Pancoast’s tumor.
5. To understand the importance of obtaining blood pressure in both arms, clinical examinations of the hand, examination for muscle atrophy, and evaluation for muscle strain and percussion of the supra clavicular fossa.
6. To understand and have knowledge of tests used to evaluate thoracic outlet, i.e. Adson’s test, hyperabduction test, and costoclavicular test.
7. To understand the role of vascular lab in the diagnosis using duplex evaluation to detect thrombosis of the subclavian vein and arterial studies of the upper extremity.
8. To define the physical findings of embolization to the digital vessels and occurrence of palpable aneurysm in the supraclavicular fossa.
9. To recognize the angiographic findings related to this syndrome including false aneurysm, post stenotic dilatation, and subclavian artery occlusion.

III. Treatment
1. To be familiar with surgical techniques and anatomy for first rib resection (transaxillary, supraclavicular, total anterior scalenotomy).
2. To define specific complications related to the surgical approach (traction injuries to the brachial plexus, pneumothorax, injury of the subclavian artery, injury to the subclavian vein, air embolus as a result of subclavian vein injury, nervous system injury, i.e. long thoracic nerve, intercostobrachial nerve, musculocutaneous nerve).
3. To be aware of the symptoms and incidence of these complications and nerve injuries.
4. To be familiar with the management of subclavian artery aneurysms including the use of graft materials and treatment of distal emboli.
5. To be familiar with thrombolytic therapy in the management of subclavian vein thrombosis.
6. To define the timing of a 1st rib resection with regard to subclavian vein thrombosis.
7. To be aware of the incidence of recurrence of thoracic outlet syndrome.
8. To be aware of the incidence of litigation pertaining to the diagnosis and treatment of thoracic outlet syndrome.
9. To have an understanding of the treatment options to include conservative approaches such as physical therapy and treatment of muscle spasm.

References
4. Sanders RJ, Cooper MA. Surgical management of subclavian vein obstruction, including six cases of subclavian vein bypass. Surgery 1995;118:856-863
8. **Acute Arterial Occlusion**
Keith Calligaro, M.D., David Drezner, M.D., Frank Veith, M.D.

I. **Anatomy and Pathophysiology**
1. To understand the various causes of acute arterial thrombosis including chronic atherosclerosis, hypercoaguable conditions, catheters and medical devices, and drug injections.
2. To understand various sources of peripheral arterial emboli including the heart (and underlying factors including myocardial infarcts, valve disease, atrial fibrillation, intracardiac tumors), arterial aneurysms and ulcerative plaques.
3. To define the variable interval of acute arterial ischemia before irreversible changes of the muscle and peripheral nerves begin to occur.
4. To understand the reasons for the high morbidity and mortality associated with acute arterial occlusion even when treatable by simple, straightforward operations.
5. To understand impaired reflow phenomenon including cellular edema, vascular lumen narrowing, capillary occlusion, and oxygen derived radicals.
6. To understand ischemia-reperfusion syndrome and its' complications, including compartment syndrome, hyperkalemia, metabolic acidosis, myoglobinuria and renal insufficiency, and pulmonary insufficiency.
7. To understand the etiology and clinical presentation of “blue-toe syndrome”.
8. To understand how the degree of arterial collateralization, in particular chronicity of underlying arterial disease and site of arterial occlusion in reference to major collaterals, affects severity and course of symptoms.

II. **Diagnostic Evaluation**
1. To understand the classic signs and symptoms of acute arterial insufficiency (pallor, decreased temperature, pulselessness, paraesthesias, paresis, pain) along with other more subtle findings such as poor venous filling.
2. To be able to recognize features of the viable, threatened and irreversibly ischemic extremity.
3. To correlate other systemic clinical findings with the likely cause of acute arterial occlusion including atrial fibrillation, claudication or a past history of unexplained previous arterial or venous clotting.
4. To understand the utility of doppler studies of peripheral arteries.
5. To understand the indications for preoperative arteriography in the setting of acute arterial occlusion.
6. To understand arteriographic findings suggestive of embolus or thrombus due to underlying arterial stenosis.

III. **Treatment**
1. To understand the role of heparin to prevent propagation of thrombus and protect the distal arterial tree.
2. To understand the benefits of mannitol for patients with advanced acute arterial occlusion.
3. To understand the importance of hydration and correcting electrolyte imbalances.
4. To understand the role of thrombolysis as the initial treatment of acute arterial occlusion and its role intraoperatively.
5. To understand the value of full preoperative arteriography in localizing the level of occlusion, the presence of other occlusions and stenoses, and suitable vessels for a bypass should it be needed.
6. To understand the importance of appropriate prepping and draping of the patient to gain access for possible venous conduits and appropriate inflow and outflow arteries.
7. To make correct decisions concerning the proper locations and type of arteriotomy depending on whether an embolus is the likely source of acute arterial occlusion or thrombus secondary to underlying chronic arterial stenosis.
8. To understand the proper technique when using thromboembolectomy catheters.
9. To understand the importance of completion arteriography.
10. To understand the indications for and technique of fasciotomy.
References
9. **Diabetic Foot Problems**
Frank W. LoGerfo, M.D., Jennifer Doyle, M.A.

I. Anatomy and Pathophysiology
1. To define the normal arterial and venous anatomy of the circulation of the foot.
2. To demonstrate an understanding of the etiology of three pathogenic mechanisms underlying problems of the diabetic foot:
   a. ischemia.
   b. neuropathy
   c. infection (polymicrobial nature)
3. To outline factors that can affect blood glucose levels in the peri- and postoperative period

II. Evaluation and Diagnosis
1. To demonstrate an understanding of the presenting signs and symptoms of three pathogenic mechanisms underlying problems of the diabetic foot:
   a. ischemia: microvascular abnormalities, atherosclerosis, pattern of atherosclerosis, tibial vessel disease, mediocalcification.
   b. neuropathy: motor, foot deformities, charcot foot, sensory neuropathy, neuroinflammatory response, manifestations of autonomic neuropathy
   c. infection: altered clinical picture, metabolic consequences, polymicrobial nature
2. To understand the limitations of various non-invasive tests in the diagnosis of ischemia, the effect of calcified vessels, the role PVR, toe pressures
3. To understand the role of angiography
   a. susceptibility to contrast induced ARF
   b. role and techniques of hydration
   c. need for visualization of foot arteries
4. To evaluate ulcer for ischemia, infection, neuropathy
   a. use of sterile probe
   b. role of foot films and interpretation, appearance of charcot changes
5. To accurately interpret clinical laboratory results, pathology reports, and radiographic studies
6. To synthesize historical findings, physical examination and laboratory data for diagnosis;
7. To identify inflow and outflow vessels on an arteriogram
8. To assesses patient’s ability to maintain level of activity (walk, drive motor vehicle, work, exercise, sexual activity)

III. Treatment
1. To understand priorities of management in diabetic patients with foot problems:
   a. timing and methods of debridement in drainage for sepsis
   b. metabolic control
   c. evaluation of ulcer, depth, sepsis, involvement of bone, tendon
   d. options for conservative management, role of foot gear, weight bearing
   e. when to evaluate for ischemia
   f. options in the management of the non-ischemic, purely neuropathic ulcer
2. To understand the role of distal bypass
   a. role of dorsalis pedis bypass
   b. alternative inflow sights
   c. outcome as a function of inflow and outflow site
3. To understand the principles and techniques of wound care, dressing changes, debridement
4. To understand the timing and methods of soft tissue closure
5. To understand the long term importance of glycemic control, weight
6. To recognize the need for careful follow-up and patient education for diabetic patients with foot problems
7. To specify proper dressings and foot care for prevention of problems in diabetic patients, e.g., the role of orthotics, foot gear, nail care
8. To categorize the prevention and management of operative and postoperative complications, including graft infections, graft thrombosis and extremity ischemia
9. To develop familiarity with all techniques of arterial reconstruction including dorsalis pedis bypass and describe the specific role these operations have in management of the diabetic foot
10. To outline the indications for and illustrate the techniques of distal reconstruction, major and minor amputations
11. To outline indications for, and illustrate techniques of:
   - debridement and drainage;
   - arterial reconstruction;
   - vascular bypass grafting;
   - amputation
12. To maintain appropriate control of diabetes peri-operatively, in:
   - NIDDM patient
   - IDDM patient
13. To present an appropriate management plan for the severely septic foot
14. To describe the general outcomes of the diabetes control and complications trial (DCCT) for the purpose of counseling patients
15. To develop appropriate plans for management
16. To manage postoperative surgery and anesthesia complications
17. To delineate and select appropriate postoperative care of patients with diabetes
18. To communicate to patients instructions and expectations for follow-up, such as:
    - pain level and location
    - possible side-effects of medications
    - level of activity and return to work
    - wound care and potential problems
    - timing of follow-up appointment
19. To arrange for home health and other outpatient services using institutional and community resources
20. To understand the role of the surgeon in taking the lead in management of the diabetic foot problem
21. To understand that care of the diabetic foot must necessarily go beyond the vascular reconstruction
22. To appreciate the importance of the team to provide maximum benefit for the patient
23. To demonstrate an understanding of, and sensitivity to, patient socioeconomic concerns regarding such issues as insurance and the ability to pay for physician services, hospitalization, and prescribed medications loss of work time and wages
24. To demonstrate sensitivity and appropriate flexibility regarding patient fears and concerns, including:
    a. preoperatively - anxiety about pain
    b. postoperatively - ability to care for self, drugs, level of function, prognosis

References
10. Complications of Vascular Therapy
Dennis F. Bandyk, M.D., Jeffrey L. Ballard, M.D., Calvin B. Ernst, M.D.

I. Anatomy and Pathophysiology
1. To recognize the factors involved in loss of arterial wall and anastomotic tensile strength resulting in the development of pseudoaneurysms.
2. To define the incidence and mechanisms which led to the development of secondary aortoenteric fistulae and erosions.
3. To understand the multiple etiologic factors associated with increased risk of infection following arterial surgery, including biomaterial implantation, host immune factors, concomitant medical conditions, nature and magnitude of bacterial contamination, and wound healing complications.
4. To understand virulence factors of gram-positive and gram-negative microorganisms involved in vascular graft infections.
5. To understand mechanisms involved in bacterial contact, adherence, and colonization of prosthetic graft material.
6. To understand the etiologies causing absence of graft incorporation and perigraft fluid collections including infection, seroma, hematoma, and lymphocele.
7. To define the normal arterial circulation of the colon and anatomic variations produced by abdominal aneurysm repair and prior colectomy.
8. To understand the etiologies causing failure of graft incorporation and perigraft fluid collections including infection, seroma, hematoma, and lymphocele.
9. To recognize anatomic and hemodynamic conditions which can result in graft occlusion including myointimal hyperplasia, atherosclerotic disease progression, anastomotic false aneurysm formation, graft entrapment, low flow, thromboembolism, hypercoagulable states, and infections.
10. To understand the etiologic differences between immediate and late graft occlusions.
11. To define the incidence and mechanisms of prosthetic graft dilatation.
12. To understand the expected incidence and etiologies of wound healing complications including hematoma, infection, and lymphocele.
13. To recognize non-vascular complications associated with arterial therapy including cardiac ischemia, renal failure, and neurologic deficits.
14. To understand the normal arterial circulation of the spinal cord and the pathophysiology of paraplegia caused by spinal cord ischemia.

II. Diagnostic Evaluation
Pseudoaneurysms
1. To recognize the clinical manifestations of pseudoaneurysm following arteriography, percutaneous transluminal angioplasty, and bypass grafting.
2. To define the appropriate diagnostic evaluation of pseudoaneurysm including the use of duplex ultrasound, computed tomography, magnetic resonance imaging, and arteriography.
3. To recognize the operative findings of infected anastomotic false aneurysm.

Aortoenteric Fistulae/Erosions
1. To understand characteristic symptoms and signs of secondary aortoenteric fistula/erosion including prior aortic graft implantation, herald gastrointestinal bleeding, fever, and concomitant anastomotic false aneurysm.
2. To define the appropriate diagnostic evaluation of suspected secondary aorto- or graft-enteric fistula including upper endoscopy, anatomic imaging techniques (CT, MRI, arteriography), and radionuclide functional scans.
3. To understand the role of operative graft exploration in patients with recurrent GI bleeding and normal GI endoscopy.
Vascular Graft Infections
1. To define the epidemiology of prosthetic graft infection.
2. To understand the characteristic signs and temporal presentation of acute versus late-appearing graft infections including sepsis, GI or perigraft bleeding, fever, malaise, false aneurysm, abdominal, back, or groin pain.
3. To understand the usefulness of various microbiologic culture (agar media, broth media) and recovery (swap culture, biomaterial culture, CT-directed aspiration) techniques in the diagnosis or confirmation of graft infection.
4. To understand the parameters of serologic testing that support the clinical diagnosis of vascular graft infection.
5. To define the appropriate diagnostic evaluation of suspected graft infection including microorganism recovery techniques, functional and anatomic graft imaging, and arteriography.

Colon Ischemia after Aortic Surgery
1. To understand the characteristic initial signs and symptoms suggestive of colon ischemia.
2. To define pre- post-operative clinical conditions that may predispose to colon ischemia after after surgery including visceral occlusive disease (meandering mesenteric artery), prior color surgery, ligation of inferior mesenteric artery, ruptured abdominal aortic aneurysm, postoperative shock.
3. To understand the usefulness of Doppler ultrasound and photoplethysmography in the operative diagnosis of colon ischemia.
4. To define the appropriate diagnostic evaluation for suspected colon ischemia following aortic surgery including the use of rigid and flexible sigmoidoscopy, colonoscopy, and operative exploration.
5. To describe the endoscopic features of the severe and mild (reversible) forms colon ischemia after aortic surgery.

Occluded Prosthetic Grafts
1. To recognize the symptoms and signs of limb ischemia associated with graft thrombosis.
2. To understand the role and the interpretation of noninvasive vascular testing techniques used for the diagnosis of graft thrombosis including Doppler-derived limb blood pressure measurements, velocity waveform analysis, pulse volume recordings, and duplex scanning, .
3. To define the appropriate diagnostic evaluation of graft occlusion based on severity of limb ischemia.
4. To describe the angiographic features of graft occlusion which indicate embolic versus thrombotic occlusion, and the potential for catheter-directed thrombolysis as a treatment option.

Perigraft Seroma and Graft Dilatation
1. To define the clinical presentation of perigraft seroma and graft dilatation including symptoms, signs, and postoperative appearance time.
2. To understand the usefulness imaging techniques (ultrasound, CT, MRI, arteriography) in the diagnosis of etiologic factors associated with failure or graft incorporation.
3. To describe the features of aspirated perigraft fluid which distinguish between chronic perigraft seroma and low-grade graft infection caused by S. epidermidis.
4. To understand the graft types associated with dilatation.

Wound Complications
1. To define the incidence and clinical manifestations associated with wound hematoma, infection, lymphocele, and dermal necrosis following arterial surgery.
2. To define the classification of wound infection following arterial bypass grafting.
3. To define the essentials of diagnosis to distinguish infectious from non-infectious wound complications.

Non-Vascular Complications
1. To understand the clinical symptoms and signs, and ECG features of cardiac ischemic.
2. To define the parameters of serologic and urine testing that characterize acute renal failure.
3. To understand the clinical symptoms and signs of neurologic deficit associated with spinal chord ischemia, injury to peripheral nerves, and cauda equina syndromes.
4. To define the appropriate evaluation of paraplegia following aortic surgery.

III. Treatment

Pseudoaneurysm
1. To define the anatomic features of false aneurysms which should be repaired.
2. To understand techniques for surgical exposure and proximal control of aortic, femoral, and other peripheral artery false aneurysms, including the use of balloon-tipped catheters to prevent backbleeding.
3. To define the role of duplex-guided ultrasound for the treatment of common femoral artery pseudoaneurysms following diagnostic arteriography or percutaneous endovascular procedures.
4. To understand the role of interposition grafting to normal artery wall in the treatment anastomotic false aneurysm.

Aortoenteric Fistulae/Erosions
1. To understand the role of staged-remote versus immediate-sequential bypass in treatment of aorto-enteric fistula based on severity of GI bleeding and degree of systemic sepsis.
2. To be familiar with surgical techniques involved in ex-situ bypass, total and partial graft excision, restoration of GI tract continuity, and in situ graft replacement using autologous venous graft, endarterectomized arteries, allograft, and antibiotic-bonded vascular prostheses.
3. To be familiar with surgical techniques of aortic ligation including treatment or aortic sepsis involving the renal or visceral arteries.
4. To define the nature and duration of antibiotic therapy associated with treatment of secondary graft-enteric fistulae/erosions.
5. To define the follow-up of patients treated or aortoenteric fistula/erosion.

Vascular Graft Infections
1. To understand the role local treatment and other graft preservation techniques, including muscle flap coverage, in the treatment of exposed arterial grafts and graft infections without anastomotic involvement.
2. To understand the usefulness of in situ graft replacement techniques using autologous, allograft, and vascular prosthetic grafts in selected patients with vascular graft infections, including selection of treatment method based on clinical manifestations, microbiology, and operative findings.
3. To be familiar with antibiotic therapy based on susceptibility testing in the treatment of arterial graft infections.
4. To be familiar with surgical techniques for excision and ex-situ bypass of infected aortic, peripheral, and carotid arterial reconstructions/bypass grafts.
5. To understand the role of graft excision and arterial ligation in patients with graft infection and adequate collateral circulation.
6. To be familiar with surgical techniques for the treatment of aortic stump sepsis or disruption.
7. To define the expected outcome of patients treated for aortic, infrainguinal, or carotid graft infections.

Colon Ischemia after Aortic Surgery
1. To be familiar with criteria for IMA re-implatation during aortic surgery.
2. To understand the role and technique of colon resection in treatment of severe ischemia.
3. To define the treatment and follow-up of mild colon ischemia following aortic surgery.

Occluded Prosthetic Grafts
1. To be familiar with surgical techniques useful in the treatment of immediate versus late graft occlusions.
2. To define the role of thrombolysis versus surgical intervention for graft occlusion/thrombosis.
3. To define the indications for graft thrombectomy and revision versus graft replacement.
4. To define the role of endovascular techniques (angioscopy, PTA, stent placement) as adjuncts to graft revision procedures.
5. To be familiar with extra-anatomic bypass grafting techniques in treatment of aortofemoral graft limb occlusion.
6. To understand the role of anti-thrombotic therapy in treatment of graft thrombosis.

Perigraft Seroma and Graft Dilatation
1. To be familiar with graft replacement techniques as treatment for perigraft seroma and graft structural failure.
2. To understand the importance of microbiologic recovery techniques, including broth culture of graft material, to exclude a biofilm infection.
3. To define the surveillance of prosthetic grafts following implantation to diagnose dilatation, failure of graft incorporation/healing, and anastomotic false aneurysm.

Wound Complications
1. To understand the role of prophylactic antibiotics in the prevention wound and graft infections.
2. To understand the standard surgical principles used to treat wound necrosis, hematoma, and infection.
3. To be familiar with non-surgical and surgical techniques useful in the treatment of lymph fistula, lymphoceles, and postoperative lymphoedema.

Nonvascular Complications (Cardiac, Renal, Neurologic)
1. To understand the role of pre-operative testing, intra-operative monitoring, and post-operative measures to prevent cardiac ischemia.
2. To be familiar with renal preservation techniques associated with aortic and renal surgery.
3. To be familiar with techniques to improve spinal cord perfusion during aortic surgery.

References

11. **Management of Vascular Trauma**
David Rosenthal, M.D., Robert Batson, M.D., Joseph Mills, M.D.

I. **Etiology and Pathophysiology**
1. To understand the mechanism of vascular injury to the upper extremity, thoracic aorta, abdominal aorta and its branches, and lower extremities.
2. To recognize the clinical importance of penetrating vascular trauma (penetrating objects), significance of different gunshot wounds (high/low velocity) and the blunt or crush injury to the vascular system.
3. To define how vascular reconstructive procedures and the failure of these procedures affect the circulatory system.
4. To understand the mechanism of iatrogenic vascular injury and its prevention.

II. **Diagnostic Evaluation**
1. To understand the characteristic signs and symptoms of acute vascular compromise.
2. To demonstrate an understanding of the wounding mechanism, assessment of the wound and characteristic findings of the affected extremity distal to the wound and associated injuries.
3. To understand the usefulness of alternative imaging techniques (ie two plane x-ray, Doppler/duplex color flow ultrasonography, venography, angiography, MRI and CT scans) in the management of vascular trauma.
4. To define the characteristic diagnostic finding of imaging techniques in vascular trauma.

III. **Acute Arterial Injuries**
1. To understand the characteristic signs and symptoms of acute arterial injury.
2. To define the clinical features of major arterial injury.
3. To understand the indications for noninvasive (Doppler or duplex color flow ultrasonography CT, MRI) and invasive (arteriography, venography) diagnostic studies.
4. To define the preoperative assessment and management of the patient with a major arterial injury.
5. To understand the operative management of acute arterial injury and the management of concomitant venous or visceral injuries.
6. To define the operative approach for specific arterial injuries (ie left and right subclavian).
7. To understand the management of postoperative complications and the management of associated injuries.

IV. **Venous Injuries**
1. To understand the characteristic signs and symptoms of acute venous injury.
2. To define the clinical features of major venous injury.
3. To understand the indications for noninvasive (Doppler or duplex color flow ultrasonography CT, MRI) and invasive (venography) diagnostic studies.
4. To define the preoperative assessment and management of the patient with a major venous injury.
5. To understand the operative management of combined arterial and venous injuries, technical management of venous injuries (ie ligation, lateral suture repair, end-to-end anastomosis, venous patch graft or venous replacement graft).
6. To define operative approach and appropriate management of specific major venous injuries (ie management of retro hepatic IVC, subclavian vein).
7. To understand the management of postoperative complications, and associated injuries.

V. **Arteriovenous Fistulas (AVF)**
1. To understand the characteristic signs and symptoms of AVFs.
2. To understand the mechanism of injury associated with traumatic AVFs.
3. To define the pathophysiology of AVFs (ie peripheral vascular resistance, heart rate, stroke volume, cardiac output and blood pressures).
4. To understand the indications for noninvasive and invasive diagnostic studies.
5. To define and understand treatment options (ie invasive radiologic procedures, endovascular procedures, and operative techniques).

VI. Iatrogenic Injuries
1. To define the mechanism of the iatrogenic injury.
2. To understand the clinical features associated with the iatrogenic injury.
3. To understand the indications for noninvasive and invasive diagnostic studies suspected iatrogenic injury.
4. To define the indications for nonoperative vs. operative treatment of iatrogenic injury.
5. To understand the management and potential complications associated with an iatrogenic injury.

VII. Concomitant Fracture and Neurologic Injuries
1. To understand the characteristic signs and symptoms of associated fractures and neurologic injuries with vascular trauma.
2. To understand the anatomic relations with fractures, neurologic injury and the vascular system.
3. To define the mechanism of injury from fracture, dislocation, or subluxation.
4. To understand the influence of penetrating, blunt and crush injuries on the vascular system.
5. To define the noninvasive and invasive diagnostic tests associated with fracture and neurologic injury and the vascular system.
6. To define associated reconstructive procedures associated with fracture, neurologic injury and the vascular system.
7. To understand the postoperative management of the patient with combined vascular, fracture, or neurologic injury.

VIII. Nonoperative Management of Vascular Injuries
1. To define the clinical criteria and indications for nonoperative versus operative management of patients with vascular injuries.
2. To define the clinical pathology and mechanism of injury (penetrating, crush, blunt) associated with combined vascular and visceral injuries.
3. To define and understand the surgical anatomy in relationships of the abdominal aorta and its major branches to the abdominal organs.
4. To define the role of the surgical technique (ie x-rays, peritoneal lavage, laparoscopic assessment, systoscopy, proctosigmoidoscopy, IVP, arteriography, etc) with suspected vascular and visceral injury.
5. To define the operative management of the patient with combined vascular and visceral injury.
6. To demonstrate an understanding of postoperative care for critically ill patients with combined vascular and visceral injuries, potential complications and their appropriate management.

References
Thoracic/Mediastinal

Carotid/Subclavian/Vertebral
3. Hiatt JR, Busuttil RW, Wilson SE. Impact of routine arteriography on management of penetrating neck

Renal

Combined Orthopedic/Vascular Injuries

Extremities

Venous Injury

Diagnostic Studies
2. Johansen K, Lynch K, Paun M, Copass M. Noninvasive vascular tests reliably exclude occult arterial
12. **Venous Thromboembolic Disease**
Anthony J. Comerota, M.D., H. Edward Garrett, Jr., M.D., Richard Welling, M.D.

**I. Etiology, Risk Factors, Epidemiology and Pathophysiology**
1. To understand that Rudolf Virchow, the Father of cellular pathology, wrote the classic triad of stasis, hypercoagulable state and vein wall damage leading to venous thrombosis.
2. To understand that all three elements can be involved in patients undergoing elective operations, causing postop DVT remote from the operative wound.
3. To understand that risk factors are quantitative and that increasing the number of risk factors increases the likelihood of venous thromboembolic complications.
4. To understand that not all risk factors are created equal. Malignancy, older age, obesity, long bone fractures, joint replacement, pelvic operations and a previous history of DVT/PE carry more weight (and higher risk) than other considerations.
5. To be familiar with the known hypercoagulable states, and to understand the relative frequency, mechanism of action and treatment of each. (These include: anticardiolipin/antiphospholipid antibodies, lupus anticoagulant, protein C and protein S deficiency, antithrombin III deficiency, hyperfibrinogenemia, plasminogen deficiency, factor V Leiden mutation (activated protein C resistance), heparin induced thrombocytopenia, Coumadin (warfarin) induced skin necrosis.
6. To realize that pulmonary embolism is the most common preventable cause of death in hospitalized patients.
7. To understand that many patients, and perhaps a majority, receive inadequate DVT prophylaxis.
8. To understand the alterations of coagulation which occur during pregnancy.

**II. Spectrum of Venous Thrombosis**
1. To understand that asymptomatic DVT can be dangerous (80% of fatal pulmonary emboli occur in patients who do not carry the diagnosis of acute DVT).
2. To understand that 20-30% of isolated calf DVT will extend if untreated.
3. To understand that the superficial femoral vein is actually the main deep vein of the thigh.
4. To appreciate that as an increasing number of segments are involved with venous thrombosis, the clinical picture of acute DVT is increasingly severe and the more problematic the post-thrombotic sequelae.
5. To understand that phlegmasia alba and phlegmasia cerulea dolens refer to the clinical findings resulting from iliofemoral DVT, not that the underlying etiology is different.
6. To appreciate that venous gangrene is not equivalent to phlegmasia cerulea dolens.
7. To appreciate the difference that extensive greater saphenous thrombosis is best treated by ligation and stripping whereas, extensive greater saphenous thrombophlebitis is best treated by ligation of the saphenofemoral junction, warm soaks, compression and nonsteroidal anti-inflammatory agents.
8. To appreciate that short segment distal superficial disease is best treated symptomatically.

**III. Diagnosis**
**Goals:**
1. To understand that the absence of clinical findings does not exclude deep venous thrombosis.
2. To appreciate that if the thigh is swollen, the common femoral vein and/or iliac veins, or the superficial femoral and profunda must be involved with the thrombotic process, assuming acute DVT is the etiology of swelling.
3. To understand that physiologic tests, including a venous doppler, impedance plethysmography (IPG), phleborheography (PRG), air plethysmography (APG), or any maximal outflow technique cannot detect nonocclusive venous thrombosis.
4. To appreciate that physiologic tests are inadequate for use as screening tests and inadequate as endpoint testing for efficacy of DVT prophylaxis.
5. To appreciate that ascending phlebography is the traditional gold standard for diagnosis of DVT, which is
being replaced by venous duplex imaging.
6. To understand that the primary diagnostic criterion for DVT with ascending phlebography is visualized thrombus. Nonfilling of a deep vein is a secondary criterion.
7. To appreciate that with ascending phlebography artifacts are due to flow voids from nonopacified blood draining from tributaries, external compression, and laminar flow.
8. To know the appropriate indications for evaluation for a hypercoagulable state.
9. To appreciate that in patients with DVT/PE, blood samples drawn for a hypercoagulable evaluation should be obtained before anticoagulation is initiated.
10. To appreciate that a common finding of a patient with lupus anticoagulant (a misnomer) is prolongation of the PTT on a routine screening blood test.
11. To appreciate that the function of activated factor C is to reduce the activity of factor Va and VIIIa.
12. To appreciate that protein C is vitamin K dependent, has a short half-life, and plasma levels are rapidly reduced by warfarin compounds.
13. To appreciate that antithrombin III is also known as heparin cofactor and is lowered by therapeutic levels of heparin.
14. To appreciate that antithrombin IIIa is significantly increased (approximately 750x) with low dose subcutaneous heparin, which is the basis for low dose heparin prophylaxis.
15. To understand that if DVT is suspected in the pregnant woman and the noninvasive test results are equivocal, ascending phlebography should be performed.

IV. Treatment

Goals:
1. To understand the multiple actions of heparin, the reasons for heparin resistance and the complications of heparin.
2. To understand that platelet counts must be monitored during heparin therapy regardless of the dose or route of administration.
3. To appreciate that the PTT value does not correlate with bleeding complications in patients receiving therapeutic anticoagulation who do not have identifiable comorbidities.
4. To appreciate that early inadequate anticoagulation (sub-therapeutic PTT) increases the risk of recurrent venous thrombosis 15x.
5. To appreciate that warfarin compounds can be started immediately after the heparin is therapeutic.
6. To appreciate that continuous IV heparin is associated with a better therapeutic outcome and fewer bleeding complications than bolus IV or high dose subcutaneous injection.
7. To appreciate that heparin induced thrombocytopenia (HIT) occurs in 4-6% of patients given unfractionated heparin, and is not dose related.
8. To understand that there are two types of HIT, immediate onset and delayed onset (5-10 days), with platelet counts falling to 40% of baseline or less, or absolute platelet counts < 150,000.
9. To understand that HIT is a result of an IgG-Ab to the platelet membrane causing platelet aggregation.
10. To understand that thrombocytopenia in the presence of heparin induced antibodies is associated with an extremely high risk of thrombotic complications, whereas a patient who is antibody positive but does not drop their platelet count does not have an increased risk of thrombotic complications.
11. Once HIT is diagnosed (or suspected), all heparin must be avoided.
12. To understand that HIT occurs significantly less in patients receiving low molecular weight heparin compared to unfractionated heparin.
13. To appreciate that warfarin compounds can produce skin necrosis when given to patients who have a heterozygote protein C deficiency.
14. To understand that in patients with warfarin induced skin necrosis, warfarin compounds cause protein C to drop thereby increasing activity of factors Va and VIIIa, thereby causing increased coagulation.
15. To appreciate that at least six months of oral anticoagulation is required for first time proximal DVT to adequately avoid recurrences.
16. To understand that low molecular weight heparin, given in weight adjusted dose subcutaneously once daily, is at least as effective and possibly more effective as IV unfractionated heparin for acute DVT.
17. To appreciate that the action of low molecular weight heparin is reduction of factor Xa activity, and it does not affect the PTT.
18. To understand the mechanism of action and the relative merits/risks of fibrinolytic therapy for acute deep venous thrombosis.
19. To appreciate that systemic fibrinolytic therapy for iliofemoral DVT is likely to fail, and that catheter-directed intra-thrombus thrombolysis is preferred.
20. To appreciate that venous thrombectomy is an effective option for patients with acute iliofemoral DVT.
21. To appreciate that the current operative technique of venous thrombectomy has improved compared to the early procedures.
22. To understand that a complete preop evaluation of the contralateral iliofemoral system and vena cava is important prior to venous thrombectomy.
23. To appreciate that an on-table completion phlebogram and correction of an underlying iliac vein stenosis is crucial to successful venous thrombectomy.
24. To appreciate that vena caval filters do not "treat acute DVT", they prevent large pulmonary emboli from occurring.
25. To appreciate that a Bird's nest filter is indicated for patients with a large vena cava.
26. To know reasons why warfarin should be avoided during pregnancy.
27. To understand that the indications for vena caval filters during pregnancy are the same as the non-pregnant patients, however, the filter should be placed in the supra-renal position.
28. To understand that those pregnant patients requiring heparin prophylaxis increase their heparin requirements during the second and third trimester.

V. Pulmonary Embolism

Goals:
1. To appreciate that pulmonary emboli occur without clinical warning in the majority of the patients.
2. To appreciate that the majority of the deaths from pulmonary emboli occur within 1-2 hours of the embolic event, and that untreated pulmonary embolism is associated with a 30% mortality.
3. To understand the typical signs/symptoms and the usual chest x-ray, blood gas and EKG findings in patients with large pulmonary emboli.
4. To appreciate the proper use of ventilation perfusion lung scan, and understand the valuable integration of predictive values based upon clinical suspicion of PE. (PIOPED data)
5. To appreciate that thrombolysis of pulmonary emboli results in better cardiopulmonary hemodynamic parameters than standard anticoagulation.
6. To understand the indications for operative pulmonary embolectomy and to appreciate that patients considered for a pulmonary embolectomy should be offered high dose fibrinolytic therapy first (if there are no contraindications).

References
13. **Chronic Venous Insufficiency**  
John F. Eidt, M.D., Dhiraj M. Shah, M.D., James N. Thomas, M.D.

I. Anatomy & Pathophysiology  
1. To review normal venous anatomy: superficial, deep and perforating veins, greater saphenous vein (GSV), lesser saphenous vein (LSV), femoral, popliteal & tibial vessels.  
2. To describe the major venous anatomic variants of clinical importance including left sided inferior vena cava, retroaortic and circumaortic left renal vein.  
3. To understand normal venous hemodynamics and the derangements associated with chronic venous insufficiency.  
4. To review the epidemiology of chronic venous insufficiency.  
5. To understand the function of normal venous endothelium and its alteration in chronic venous insufficiency (e.g. production of prostacyclin, plasminogen activator, heparans and thrombomodulin).  
6. To outline the major risk factors for venous thrombosis including acquired and hereditary hypercoagulable conditions.  
7. To review the postulated consequences of venous thrombosis on normal venous patency and valve function.  
8. To explain the relationship between acute deep vein thrombosis and the eventual development of chronic venous insufficiency.  
9. To define:  
   - Chronic venous insufficiency  
   - Varicose veins  
   - Perforating veins  
   - Telangiectasia  
   - Sclerotherapy  
   - Lipodermatosclerosis  
   - Venous claudication  
   - Phlegmasia cerulea dolens  
10. To review the postulated chain of events that leads to lipodermatosclerosis and venous ulceration.  
11. To understand that chronic venous disease is defined as an abnormally functioning venous system caused by venous valvular incompetence with or without venous outflow obstruction which may affect the superficial venous system, the deep venous system or both.  
12. To understand that the term post-thrombotic may be used if the patient has experienced an objectively documented episode of DVT. The term postphlebitic syndrome should not be used because this implies the presence of an inflammatory component that is infrequently confirmed.  
13. To review the role of inflammatory cells in the development of venous stasis ulcers.  
14. To understand that chronic venous insufficiency can lead to significant morbidity and may be disabling.  
15. To differentiate congenital from acquired forms of venous insufficiency.

II. Diagnostic Evaluation  
1. To review the "CEAP" classification system of chronic venous insufficiency: Clinical condition, Etiology, Anatomic distribution and Pathophysiology.  
2. To understand and differentiate the three etiologic categories of venous dysfunction: congenital, primary (acquired, undetermined cause) and secondary (acquired, e.g. post-thrombotic or post traumatic).  
3. To differentiate the clinical features of superficial venous insufficiency from deep vein (or combined) insufficiency.  
4. To review the noninvasive and invasive evaluation of the venous system including ascending & descending venography, photoplethysmography, air plethysmography, and duplex scanning.  
5. To describe the characteristics of venous stasis ulcers and differentiate from other types of ulcers including arterial, neuropathic, malignant, infectious and inflammatory (vasculitis).  
6. To differentiate stasis dermatitis from other causes of dermatitis in the lower leg.
III. Treatment
1. To describe the types of available therapy for superficial venous insufficiency (varicose veins) including elastic stockings, elevation, sclerotherapy, laser treatment, stab evasion, stripping.
2. To review the strengths and drawbacks of agents used in sclerotherapy including hypertonic saline, sodium tetradecyl sulfate, polidocanol etc.
3. To recognize the relative risks and benefits associated with treatment of varicose veins including DVT, infection, skin slough, etc.
4. To define the principles of non-operative management of lower extremity chronic venous insufficiency: ambulation, elevation, elastic support.
5. To review the technique of ambulatory phlebectomy (microstab evulsion) for varicose veins including the use of tumescent (large volume, low strength) local anesthesia.
6. To review the indications for surgery and surgical options in the treatment of chronic venous insufficiency, varicose veins, venous obstruction and stasis ulceration.
7. To describe the procedures for treatment of valve reflux including valvuloplasty, vein valve autotransplantation and vein segment transposition.
8. To discuss the relative risks and merits of procedures designed to decrease the degree of valve reflux.
9. To describe the procedures designed to treat venous outflow obstruction including autogenous or prosthetic bypass and venous disobliteration.
10. To describe the non-operative management of venous stasis ulcers including UNNA Boot, etc.
11. To review the operative procedures for venous ulceration including subfascial ligation.
12. To outline the technical features of 1) endoscopic subfascial ligation of incompetent ankle perforating veins in the treatment of chronic venous insufficiency and 2) endoscopic excision of varicose veins.
13. To describe the proposed pharmaceutical treatment of venous stasis ulcers: pentoxyphyllines, prostaglandins, antibiotics, growth factors, etc.

References
14. Lymphedema
Louis M. Messina, M.D., Robert B. Smith, M.D.

I. Anatomy
1. To know the anatomy of the adult lymphatic system from the level of the terminal lymphatics to the cisterna chyli
2. To know the microscopic anatomy of the lymphatic capillaries and conducting lymph vessels and specifically how they differ from veins and arteries.
3. To understand the physiological determinants of lymph flow, including intrinsic contractility of lymph vessels, increased interstitial pressure, muscular activity, arterial pressure, respiratory pressure, and gravity.
4. To know the major differences that distinguish the physiology of the lymphatic system from the venous system.
5. To know the major purposes of the lymphatic system, including transport of interstitial fluid and macromolecular proteins lost from capillaries, bacterial and fungal infections, foreign material.
6. To know the classification of causes of lymphedema, including:
   A. Primary lymphedema, Congenital (onset before one year of age)
      1. Non-familial
      2. Familial (Milroy’s Disease)
   B. Primary lymphedema, Praecox (onset 1 to 35 years of age)
      1. Non-familial
      2. Familial (Meige Disease)
   C. Primary lymphedema, Tarda (onset after 35 years of age)
   D. Secondary lymphedema, including filariasis, lymph node excision and radiation, tumor invasion, infection, and trauma
      1. To understand the functional classification of lymphedema based on the underlying lymphatic anatomy as determined by lymphangiography.
      2. To understand how lymphedema develops the compensatory mechanisms that develop in response to increased interstitial pressure, and the tissue effects of chronic lymphatic obstruction including impaired immune cell trafficking, lymphatic obstruction, and chronic intestinal inflammation.
      3. To understand the secondary consequences of long-standing lymphedema: infection, fibrosis, and neoplasia.
      4. To understand the functional and anatomical abnormalities that cause chylous disorders.
      5. To understand the consequences of the loss of chyle into body cavities or through a chylocutaneous fistula.

II. Diagnosis of Lymphedema
1. To understand classic clinical classifications of lymphedema based on etiology (primary vs secondary), genetics (familial vs sporadic), and time of onset.
2. To understand the history and physical findings which enable the clinician to identify the cause and site of lymphatic obstruction.
3. To understand pattern of pain, edema, and skin changes that distinguish lymphedema from other causes of extremity edema.
4. To understand the clinical presentation of complications of chronic lymphedema including infection (fungal and bacterial) and malignancy.
5. To understand the nutritional and immunological consequences of chronic lymphangeiectasia with protein-losing nephropathy, chylous ascites, or chylothorax.
6. To understand the accuracy and limitations of the most frequent noninvasive imaging modalities used to evaluate lymphatic disease: lymphoscintigraphy, computed tomography, and magnetic resonance imaging.
7. To understand the technique of lymphoscintigraphy, the features of a normal lymphoscintogram and the
typical scintographic findings in primary and secondary lymphedema.
8. To understand the indications, techniques, interpretation and complications of lymphangiograms.

III. Management of Chronic Lymphedema
1. To understand the techniques of non-operative management of primary and secondary lymphedema.
2. To know the mechanisms of action and effectiveness/ineffectiveness of pharmacologic agents such as diuretics, benzopyrones, and steroids in the treatment of lymphedema.
3. To understand the mechanical techniques to reduce a limb swelling
   A. To understand the technique of limb elevation.
   B. To understand the technique, advantages, and disadvantages of manual lymphatic drainage.
   C. To understand the technique of intermittent pneumatic compression, including pressure, ratio of compression/decompression, duration of therapy.
   D. To understand the technique of intermittent, non-pneumatic high pressure compression
   E. To know the role of antibiotics in the treatment and prophylaxis of recurrent cellulitis in patients with chronic lymphedema.
   1. To know the techniques for maintenance of limb size including elastic and non-elastic support.
   2. To know the indications for surgical management of chronic lymphedema
   3. To understand the technique, complication rate, and effectiveness of excisional procedures including the Charles procedure, Thompson’s buried dermal flap, suction curretage, and Sistrunk procedures.
   4. To know the indications, technique, complications rate, and outcome of direct lymphatic reconstruction such as lymphovenous anastomosis including lymphnodal-venous and lymphvenous procedures.
   5. To know the indications, technique, complication rate, and outcome of lymphatic grafting.
   6. To know indication, technique, complications rate of indirect lymphatic reconstructions such as the mesenteric bridge operation, omental flap, and autotransplantation of free lymphatic flap.
      A. To know the indications, technique, complications, and outcome of procedures for primary chylous disorders.

References
15. **Extremity Amputation**
Roger T. Gregory, M.D., G. Patrick Clagett, M.D., H. Fabio Giron, M.D.

I. **Anatomy and Pathophysiology**
1. To learn the normal anatomy of the extremities including all muscles, nerves, vessels, and bones.
2. To understand the various pathophysiologic conditions which leads to the need for an extremity amputation.

II. **Diagnostic Evaluation**

Clinical Indications for Amputation
1. To understand when acute ischemia is irretrievable.
2. To understand when chronic ischemia is unacceptable.
3. To define when amputation offers improved quality of life.
4. To be able to recognize when an ischemic limb is a threat to survival.
5. To understand when diabetic foot infections may necessitate amputation despite adequate circulation - the concept of “life threatening infection.”
6. To define the role of osteomyelitis in determining the need and type of amputation.

Determining the Level of Amputation
1. To understand the importance of proper amputation level selection.
2. To define the methods of determining amputation level by clinical criteria.
3. To define methods of determining amputation level by noninvasive methods.
4. To understand the limits of angiography.

III. **Treatment**

Lower Extremity Amputation Techniques
1. To understand the basic techniques for toe amputation, ray amputation, transmetatarsal amputation, below knee amputation, above knee amputation and upper extremity amputation.
2. To understand situations when “unusual” amputations may be appropriate, such as Choparts, Lisfranc, Symes, through-knee, hip disarticulation, hemipelvectomy, and, even, hemicorporectomy.
3. To understand the causes of stump failure, including technical problems, inadequate skin and muscle perfusion, hematoma, inadequate flaps, pressure necrosis from transected bone, and infection.

Postamputation Care, Prosthetic Management and Rehabilitation
1. To define the differences offered by soft versus rigid dressings.
2. To understand the importance of early mobilization.
3. To achieve a basic understanding of lower extremity prosthetic devices, specifically the pros and cons of immediate versus delayed prosthesis.
4. To understand how amputation technique can impact upon prosthetic application and subsequent rehabilitation.
5. To define goals of rehabilitation with individual capabilities.
6. To understand the importance of communication and participation of a multiple disciplined team approach to the amputee and the special problems presented.
7. To understand the consequences of flexion contracture following amputation.
8. To be able to recognize and manage phantom pain syndromes.

References (*excellent references*)

Texts

**Journal Articles**

16. Diagnostic Techniques
David S. Sumner, M.D., John Blebea, M.D.

Goals
I. History
1. To understand the essential components of a comprehensive vascular history.
2. To recognize symptoms relevant to vascular disease, identify salient points and understand their significance.
3. To use the information to formulate an initial diagnosis and to evaluate the severity of the likely disease process.
4. To identify confounding symptoms of similar nature produced by non-vascular diseases.
5. To obtain historical information pertinent to the evaluation of patients for operation or information that would militate against operative intervention or dictate the choice of therapy.

II. Physical Examination
1. To understand the significance of observational signs, such as skin color and texture, swelling, gangrene, and ulcers.
2. To detect and evaluate peripheral pulses, bruits, thrills, skin temperature, edema, tissue turgor, and vascular dimensions.
3. To develop the skills necessary to palpate the abdomen, neck, and extremities in order to localize sites of tenderness and to recognize the presence of masses and abnormal pulsations.
4. To be capable of performing basic neurological evaluations.
5. To interpret physical findings, understand how they contribute to the diagnosis, recognize their limitations, and be aware of other diseases that might mimic the findings.

III. Noninvasive Tests
1. To be familiar with commonly used noninvasive instruments and modalities, such as Doppler ultrasound, duplex and color-flow scanning, B-mode imaging, plethysmography (air, mercury, and impedance), magnetic resonance imaging (MRI), magnetic resonance angiography (MRA), and computerized X-ray tomography (CT), and to understand the basic principles involved in their design and operation.
2. To be familiar with noninvasive pressure measurements (including ankle/brachial indices, segmental pressures, digital pressures), arterial and venous velocity tracings, Doppler frequency spectral analysis, segmental and digital plethysmography, transcutaneous oxygen tension measurements (TcPO₂), venous outflow plethysmography, calf venous air-plethysmography (Nicolaiides method) and to understand the hemodynamic principles underlying exercise testing (treadmill walking and claudication times, post-exercise ankle pressure) and reactive hyperemia.
3. To understand the physiologic basis of these tests and their limitations, know when to order noninvasive tests, which to select and how to interpret the results.
4. To perform simple noninvasive assessments (such as Doppler venous and arterial surveys and measurement of ABIs) and be able to interpret duplex scans, MRIs, MRAs, and CT scans.

IV. Invasive Diagnostic Methods
1. To be highly skilled in the interpretation of angiograms of all arterial and venous segments.
2. To understand the limitations and inherent risks of angiography, be aware of sources of error, and know how to minimize complications.
3. To be adept at obtaining and interpreting intraoperative arteriograms and, whenever possible, to acquire the skills necessary to perform percutaneous arteriography, including catheter manipulation techniques required for selective visualization of visceral and brachiocephalic vessels.
4. To be familiar with the intraoperative use of Doppler and duplex surveys in order to answer specific questions (location and patency of vessels, stenotic sites) and to detect technical errors at the completion of
the reconstruction (residual valves, arteriovenous fistulas, thrombi, anastomotic problems).
5. To be familiar with the intraoperative applications of the angioscope.
6. To perform intraoperative and preoperative percutaneous arterial and venous pressure measurements involving the use of pressure transducers.
7. To have some knowledge of other less frequently performed tests, such as intravascular ultrasound, isotope clearance studies and uptake tests, and scintillation scans.

Site Specific Goals

I. Lower Extremity Arterial Disease
1. To identify the symptoms of intermittent claudication and differentiate them from those of orthopedic or neurological conditions.
2. To recognize symptoms of severe ischemia, (such as rest pain, tissue loss, ulcers, and gangrene); differentiate these symptoms from those of diabetic neuropathy, neurologic, venous, infectious, and other problems; and determine the relative importance of several etiologies when more than one is present.
3. To recognize and differentiate the symptoms and signs of acute arterial occlusion (pain, pallor, numbness, and motor dysfunction) from those of chronic arterial occlusive disease; to assess the urgency of the condition and the threat to limb loss; and to distinguish findings suggestive of embolic occlusion from those of arterial thrombosis.
4. To understand the contribution of noninvasive tests (ABI, plethysmography, duplex surveys, treadmill exercise, and reactive hyperemia) to the diagnosis and know when arteriography, MRA, or other more complex tests are required.
5. Based on the history and physical examination, together with the results of invasive and noninvasive tests, to formulate an accurate diagnosis of arterial disease, identify the location and extent of the obstructive process, assess its severity, and determine the need for and the urgency of interventional therapy.

II. Extracranial Cerebrovascular Disease
1. To recognize and evaluate the symptoms and signs of transient hemispheric and nonhemispheric neurologic events and to differentiate them from the symptoms and signs of permanent neurologic damage (stroke) or peripheral neuropathy.
2. To decide, based on their natural history and pathophysiologic behavior, which events require immediate attention.
3. To understand the indications for common noninvasive tests (such as duplex or color-flow scanning), how they may contribute, what their limitations are, and how they are to be interpreted; and to know when to obtain and how to interpret less commonly performed tests, such as transcranial Doppler studies or oculopneumoplethysmography.
4. To know when to order (or not to order) cerebral arteriography, how to read extracranial and intracranial views, how to measure the degree of stenosis, and how to use the findings to select the proper therapeutic approach.
5. To know when to select MRA as an alternative diagnostic method and what its comparative accuracy is compared to arteriography or duplex scanning.
6. To be able to read and interpret CT and MRI scans of the brain, know when to order these studies and how the results influence diagnosis and the need for therapeutic intervention.
7. In asymptomatic patients, to assess cervical bruits, understand their significance, and know which patients without specific signs have a high propensity for extracranial cerebrovascular disease and are likely to benefit from noninvasive diagnostic screening and possible therapeutic intervention.
8. To understand the role of duplex scanning in the follow-up of nonoperated or operated patients with known cerebrovascular disease (to detect recurrent disease or disease progression).

III. Brachiocephalic and Upper Extremity Arterial Disease
1. To recognize the signs and symptoms of brachiocephalic disease, including those of hemispheric ischemia,
vertebrobasilar ischemia, and arm claudication and ischemia.
2. To understand the role that brachial, segmental, and digital pressures play in screening for disease and the roles that duplex scanning, arteriography, and MRA play in establishing the diagnosis.

IV. Aneurysmal Disease
1. To recognize and interpret the signs and symptoms of abdominal aortic, iliac, femoral, popliteal, visceral, thoracic, carotid, and brachiocephalic aneurysms.
2. To be skilled in the palpation of the abdomen, extremities, and neck in order to recognize pulsatile masses, assess their dimensions, and differentiate those likely to be aneurysms from arterial tortuosity, tumors, or other nonvascular masses.
3. To recognize signs of impending or actual rupture including tenderness, ecchymoses, shock, or other evidence of acute blood loss.
4. To determine the urgency of operative intervention, and decide when ultrasonic, CT, or MRI confirmation is necessary.
5. To be acutely aware of the signs of complications, such as aortic-enteric fistula and high-output cardiac failure due to aorto-caval fistulae.
6. To know the indications for arteriography (or MRA) and how to interpret these studies.
7. To be alert to the indirect signs of aneurysms, such as unexplained embolic phenomena (blue toes or fingers) or sudden ischemia due to acute thrombosis or dissections.

V. Visceral Arterial Disease
1. To be familiar with the symptoms of acute visceral arterial occlusion and with the post-prandial pain patterns and weight loss associated with chronic visceral ischemia.
2. To be alert to conditions (such as atrial fibrillation, recent myocardial infarction, arterial dissections) that might lead to acute occlusion of mesenteric arteries.
3. To recognize conditions (such as congestive heart failure) that predispose to nonocclusive mesenteric ischemia.
4. To interpret visceral angiograms and know when these are needed.
5. To understand the role and limitations of duplex scanning in the diagnosis of visceral arterial stenosis.

VI. Renal Arterial Disease
1. To recognize the signs and symptoms of renal arterial occlusive disease, as manifested by the onset and severity of hypertension, and be able to determine which patients require further workup.
2. To be familiar with the diagnostic roles of selective renal vein renins, isotope clearance tests, IVP, duplex scanning, and arteriography and know the limitations and predictive value of these tests.

VII. Arteriovenous Fistula
1. To be cognizant of the systemic manifestations of large arteriovenous fistulas, including tachycardia, Branham's sign, and high-output cardiac failure and be able to differentiate between acquired and congenital fistulas.
2. To understand the diagnostic significance of a history of penetrating trauma, fractures, back surgery, and vascular catheterization and know the significance of signs, such as birthmarks, limb hypertrophy, unilateral varicose veins, vascular malformations, bruits, and thrills.
3. To be aware of the role that noninvasive pressure measurements and duplex scanning have in establishing a diagnosis, know when to order CT scans, MRI, MRA, or arteriography, and be able to interpret the results.
4. To distinguish between congenital arteriovenous fistulas and primary venous malformations.

VIII. Vasospastic Disease
1. To recognize and evaluate the symptoms of episodic digital ischemia provoked by cold exposure (Raynaud's phenomenon) and to be aware of the manifestations of vasospasm, such as changes in skin color
and temperature.
2. To identify signs of underlying autoimmune disease, such as digital atrophy, ulceration, or gangrene and other skin changes.
3. To be aware of the role that noninvasive tests (Doppler surveys, duplex scans, digital pressure measurements, plethysmographic studies, and skin temperature recordings) play in distinguishing purely vasospastic disease from vasospasm superimposed on fixed digital arterial stenoses or occlusions.
4. To know when arteriography is indicated and how to interpret the findings.

IX. Acute Venous Thrombosis
1. To recognize the signs and symptoms of acute deep venous thrombosis (DVT) and differentiate them from the signs and symptoms of cellulitis, muscle tears, superficial venous thrombosis, arterial obstruction, and a host of other causes of unilateral limb swelling, edema, pain, and cyanosis.
2. To be aware of the significance of factors predisposing to DVT, such as recent trauma, orthopedic or major abdominal surgery, malignancy or chronic illness, pregnancy, airplane or bus trips, and hypercoagulability.
3. To understand the limitations of the history and physical examination and be aware of the critical role that noninvasive testing (primarily duplex scanning and to a declining extent, hand-held Doppler and impedance plethysmography) now plays in the diagnosis of this disease.
4. To know when phlebograms, magnetic resonance studies, or CT scans are indicated and how to interpret the results.
5. To be aware of the indications for screening asymptomatic high-risk patients for occult DVT and know the limitations of the noninvasive methods used for this purpose.

X. Chronic Venous Insufficiency
1. To know the symptoms and signs of varicose veins, chronic venous obstruction, and deep venous incompetence and be able to differentiate these diseases from lymphedema, acute DVT, arteriovenous malformations, and arterial disease.
2. To recognize and evaluate the cutaneous manifestations of chronic venous insufficiency, including lipodermatosclerosis, pigmentation, dermatitis, and ulceration.
3. To know when objective testing is required to establish the diagnosis and understand how duplex scanning may contribute to the anatomic assessment by identifying the sites and distribution of chronic venous obstruction and incompetent venous valves; how air plethysmographic, photoplethysmographic, and other physiologic tests (such as ambulatory venous pressure measurements) may assist in the evaluation and assessment of the severity of physiologic aberrations; and when to order and how to evaluate ascending and descending phlebograms.

XI. Lymphedema
1. To be familiar with the historical aspects of lymphedema, noting the time of onset and the presence of previous or coexisting infections, injuries, radiation, or malignancy.
2. To be aware of the significance of the location of swelling, the type of edema (pitting or woody), the presence of cutaneous lichenification, and associated cellulitis.
3. To understand the diagnostic roles of lymphangiography and scintillation scans and when to order and how to interpret these studies.
4. To differentiate between primary and secondary lymphedema and distinguish the various forms of lymphedema from swelling due to chronic venous insufficiency.

XII. Trauma
1. To understand the importance of obtaining a history of the injury (whether it was due to blunt or penetrating trauma, gun-shot of knife); of an expeditious physical examination noting the location of the injury (entry and exit points, multiple sites or localized), the presence of external hemorrhage, hematoma,
ecchymoses, or shock, of assessing peripheral pulses, neurologic status, and respiratory compromise, and of identifying associated skeletal or visceral injuries.

2. To know when to obtain Doppler studies, peripheral pressure measurements, duplex scans, transesophageal echo studies, compartmental pressures, CT scans, X-rays, and arteriography.

XIII. Amputations
1. To recognize the need for amputation and to predict the optimum level based on a history of previous revascularization attempts, etiology of vascular obstruction, the presence of infection, diabetes, or coagulation disorders, location and severity of pain, extent of ulcers or gangrene, presence or absence of pulses, the appearance and temperature of the skin, capillary refill, and overall medical status.
2. To understand the limitations and advantages of using objective tests such as TcPO$_2$ measurement, isotope clearance, and ankle, segmental, digital, and skin pressures to select the site of amputation.

References

General

Peripheral Arterial

Arteriography, MRI

Carotid

**Abdominal, Visceral**

**Venous**
Emerging Technologies
Thomas F. Panetta, M.D., Teruo Matsumoto, M.D., Rodney A. White, M.D.

I. General
1. To understand the basic principles of emerging technologies in vascular and endovascular surgery.
2. To develop a working knowledge of the equipment, techniques, technical problems, troubleshooting and recovery techniques.
3. To understand the physical properties of devices including but not limited to wires, catheters, balloons, coils, stents, stent-grafts, filters and delivery systems. To understand the physical properties, basic engineering and evolution of devices as they relate to their clinical applications, implantation, biocompatibility, tissue reactions and interactions, graft-metallurgical interactions, wound healing, limitations and overall use in the treatment of vascular disease.
4. To understand the indications, applications, complications, management and results of imaging modalities, basic techniques, newly developed techniques and implantable devices used to treat vascular disease.

II. Imaging Modalities
1. To understand radiation physics, safety, risks, cellular effects, somatic effects, dose responses, monitoring, shielding and variations in x-ray equipment as they relate to both patients and personnel including preventative measures for safety.
2. To understand basic principles and equipment used for fluoroscopy and arteriography. To obtain a working knowledge of contrast media, road-mapping, imaging techniques, measurement techniques, parallax, hand and power injection techniques and film sequencing.
3. To understand the basic principles of intravascular ultrasonography (IVUS). To obtain a working knowledge of B-mode imaging, transducers and catheters.
4. To understand the basic principles of angioscopy. To obtain a working knowledge of endoscopes and fiberoptic technology, imaging and irrigating equipment, and channel instrumentation.
5. To understand the techniques used for preoperative, intraoperative and postoperative imaging, measurements and evaluation of endovascular techniques including ultrasonography, magnetic resonance imaging, computerized axial tomography including helical techniques with 3 dimensional reconstructions and angiography.
6. To understand the accuracy, utility, limitations and clinical importance of each modality.

III. Basic Techniques
1. To obtain a working knowledge of basic endovascular techniques. To understand individual techniques and obtain a knowledge base for standard and emerging technologies.
2. To understand the proper use of needle, catheter, guidewire, dilator and introducer techniques used to gain access to the vascular system and perform vascular interventions.
3. To understand the techniques and mechanisms of angioplasty and atherectomy.
4. To obtain a working knowledge of pharmacological and mechanical methods of thrombolysis.

IV. Emerging Technologies
1. To obtain a working knowledge of self expanding and balloon expandable intravascular stents. To understand delivery techniques, rationale for use and retrieval/recovery techniques.
2. To understand the various types and uses of occlusion techniques including sclerosing agents and occlusion devices. To obtain a working knowledge of coils, temporary and permanent occlusion balloons, and the variety of covered stent occluding devices.
3. To understand and obtain a working knowledge of endovascular grafts, covered stents and stent-grafts for the treatment of vascular disease. This includes the variety of delivery systems, attachment devices, covered stents, and stent-graft combinations and devices. The values and limitations of each of the available and potentially available devices should be understood.
4. To have a working knowledge of adjunctive interventional procedures required as retrieval, recovery or “bail out” procedures in endovascular surgery including endovascular and open techniques.
5. To understand laparoscopic and laparoscopically assisted vascular techniques for both arterial, venous and adjunctive vascular procedures.
6. To understand the role of brachytherapy in preventing intimal hyperplasia, both as an independent modality or in combination with metallic devices.
7. To understand and have a working knowledge of venous filters and venous devices.

V. Clinical Applications

1. To understand and have a working knowledge of endovascular and interventional techniques utilizing percutaneous and surgical access for the diagnosis, management and treatment of traumatic arterial and venous injuries.
2. To understand and have a working knowledge of endovascular and interventional techniques utilizing percutaneous and surgical access for the diagnosis, management and treatment of arterial occlusive disease.
3. To understand and have a working knowledge of endovascular and interventional techniques utilizing percutaneous and surgical access for the diagnosis, management and treatment of aneurysmal disease.
4. To understand and have a working knowledge of endovascular and interventional techniques utilizing percutaneous and surgical access for the diagnosis, management and treatment of cerebrovascular disease.
5. To understand and have a working knowledge of endovascular and interventional techniques utilizing percutaneous and surgical access for the diagnosis, management and treatment of venous disease including arteriovenous malformations.
6. To understand the pathophysiology and management of intimal hyperplasia and recurrent disease after endovascular intervention, endovascular graft placement and insertion of an implantable device.
7. To understand the treatment of acute and chronic complications of endovascular techniques and devices.
   To understand the pathophysiology and management of arterial injuries, endoleaks, migration, embolization, delivery system failures and attachment device failures.
8. To have a working knowledge of recovery, retrieval and “bail out” procedures for endovascular procedures. This includes both catheter based and surgical procedures.

References

18. **Risk Stratification and Risk Factors**

Bruce S. Cutler, M.D., William C. Mackey, M.D.

I. Cardiac Disease
1. Recognize the frequent association of coronary artery and peripheral vascular disease.
2. Understand the risk factors predictive of perioperative myocardial infarction or cardiac death.
3. Be able to quote basic statistics regarding the frequency of severe CAD in patients with symptomatic peripheral vascular disease.
4. Be familiar with the early and late cardiac mortality figures following major vascular surgery.

II. Anatomy and Pathophysiology
1. Describe normal coronary artery anatomy
2. Understand the clinical significance of chronic stable angina, unstable angina, recent and remote myocardial infarction and congestive heart failure
3. Understand how an imbalance of myocardial oxygen supply and demand may lead to myocardial ischemia
4. Describe those factors that may lead to an increased demand for myocardial oxygen, and/or a decreased supply that will contribute to myocardial ischemia.
5. Understand the clinical and histological difference between a subendocardial and transmural infarction.
6. Understand the effects of general and regional anesthesia on myocardial oxygen demand and myocardial ischemia.
7. Understand the most important factors present intraoperatively and in the post-operative period that contribute to myocardial ischemia.

III. Diagnosis
1. Understand the signs and symptoms of chronic stable angina, unstable angina, myocardial infarction and congestive heart failure.
2. Know the risks of operation in a patient with a recent myocardial infarction, unstable angina, or poorly compensated congestive heart failure.
3. Be familiar with the currently used methods for screening for coronary artery disease, and their limitations. (e.g. Dipyridamole thallium scanning, Exercise testing, Dobutamine stress echo, ambulatory Holter monitoring)
4. Know which patients should undergo a preoperative test for coronary artery disease
5. Know how to interpret the results of thallium scans
6. Know what further evaluation a patient with a positive study should have.
7. Know which patients should have coronary angiography prior to vascular surgery.
8. Understand that the magnitude of the operation should be tailored to the severity of the patients cardiac risk. Know when to employ an extra anatomic, or limited procedure instead of an intra-abdominal operation.
9. Understand when, during the course of a vascular operation and subsequent recovery, a patient is most likely to suffer a myocardial infarction

IV. Treatment
1. Recognize that most patients with even severe CAD can survive a major vascular operation, but they should have close postoperative cardiology follow up and subsequent consideration for coronary revascularization for the best long term survival.
2. Know when CABG may be indicated to correct severe CAD prior to peripheral vascular surgery.
3. Understand the indications for a combined CABG and CEA or AAA operation.
4. Understand the reasons for controlling myocardial ischemia intraoperatively, and during recovery from a major vascular operation
5. Know how to detect and treat myocardial ischemia postoperatively  
6. Know how to diagnose and treat common complications of myocardial infarction.

**Pulmonary Disease**

**I. Introduction**
1. Recognize that many of the same risk factors that accelerate the development of peripheral vascular disease, also cause the development of chronic obstructive pulmonary disease (COPD).
2. Understand that long operations, intra-abdominal and thoracic incisions, and poor left ventricular function increase the risk of pulmonary complications even in the absence of underlying COPD.
3. Understand that cardiac and other co-morbid conditions are more important in determining postoperative pulmonary complications than pre-existing pulmonary disease.

**II. Diagnosis**
1. Know the risk factors for pulmonary disease, including: history of tobacco use, chest wall deformities, industrial dust exposure, previous pulmonary resection, dyspnea on mild exertion, pulmonary hypertension, recurrent respiratory tract infections, bronchospasm, obesity, advanced age and hypercapnia or hypoxia at rest.
2. Understand the signs and symptoms of COPD.
3. Know what to look for in the physical examination of a patient with suspected pulmonary insufficiency.
4. Understand that clinical assessment is at least as accurate as routine preoperative pulmonary function tests in predicting which patients will have a postoperative pulmonary complication.
5. Understand that the primary benefit of preoperative pulmonary function studies is to make the diagnosis of pulmonary disease and as an aid in choosing between treatment alternatives.
6. Understand that there is no pulmonary function test, or index that can accurately predict that a patient will need prolonged postoperative mechanical ventilation.
7. Understand that general anesthesia interferes with pulmonary gas exchange and pulmonary defense mechanisms, particularly the mucociliary transport mechanism.
8. Know how to interpret the results of pulmonary function tests, and know which patients might benefit from the perioperative use of bronchodilators, antibiotics, inhalers etc.
9. Know which patients might benefit from a preoperative pulmonary or anesthesia consultation to help with the operative and postoperative management of a patient with known pulmonary insufficiency.

**III. Treatment**
1. Understand how to reduce the pulmonary risk of a vascular operation by the choice of operation and anesthesia.
2. Understand which pulmonary conditions may benefit from the perioperative use of steroids, bronchodilators, antibiotics and inhalers.
3. Understand the causes and treatment of the adult respiratory distress syndrome (ARDS).

**References**

**Cardiac Disease**
4. Hertzer NR, Beven EG, Young JR, et al. Coronary artery disease in peripheral vascular patients: A

Pulmonary
19. **Coagulation Disorders**
Richard M. Green, M.D., Donald Silver, M.D.

I. **Heparin**
1. To understand the role of antithrombin III and the dual action of heparin on thrombin (factor II) and factor Xa (IX a and XI a also).
2. To be familiar with its half-life, routes of administration and its uses both in terms of prevention of thrombosis and in treatment for thrombotic conditions.
3. To be familiar with the hematologic and nonhematologic complications.
4. To understand the intraoperative use including monitoring techniques and reversal.
5. To understand the mechanism of action and complications of protamine sulfate.

II. **Low Molecular Weight Heparin (LMWH)**
1. To understand the rationale for its development and its advantages over unfractionated heparin.
2. To understand the different mechanism of action as compared to unfractionated heparin.
3. To understand why it can be used without monitoring.
4. To understand why it is less hemorrhagic than unfractionated heparin.
5. To understand the clinical applications particularly in the patient with heparin induced thrombocytopenia and prophylaxis for venous thrombosis.
6. To understand the cost benefits of outpatient treatment of venous thrombosis.

III. **Heparin-induced Thrombocytopenia (HIT)**
1. To understand the incidence of the syndrome in patients receiving heparin, the incidence of thrombotic complications and the mortality rate.
2. To understand the risk factors associated with its development.
3. To understand the differences between Type I and Type II HIT.
4. To understand the diagnostic criteria necessary to make the diagnosis.
5. To understand the pathophysiology of antibody formation.
6. To understand the principles of management.
7. To understand the limitations of the various diagnostic tests including platelet aggregation studies, the serotonin release assay and the PF4/heparin ELISA assay.
8. To understand when further anticoagulation is indicated and what agents are available and under development.

IV. **Coumadin**
1. To understand the mechanism of action including the roles of proteins C and S.
2. To understand why heparin should be given for the first 3-4 days of coumadin treatment.
3. To understand the medical conditions, foods and common drugs that affect coumadin’s anticoagulant activity.
4. To understand how to minimize the complications of coumadin therapy.
5. To understand the American College of Chest Physicians recommendations of appropriate INR levels. This should include a working knowledge of the conditions which require higher levels.
6. To understand how and when to reverse anticoagulation in patients with and without hemorrhage.
7. To understand how to manage patients requiring surgery.

V. **Antiplatelet therapy**
1. To understand the role of platelets in primary and secondary hemostasis.
2. To understand the role of platelets in pathologic thrombosis.
3. To understand the structure of the platelet and the function of each zone.
4. To understand the sequence of platelet activation including a knowledge of the glycoprotein complexes and the role of von Willebrand’s factor.
5. To understand the various platelet agonists and antagonists are their relative strengths.
6. To have a working knowledge of antiplatelet agents currently available and their mechanisms of action. This includes an understanding of the relative strengths of the antagonists: aspirin, ticlopidine, dextran, and dipyridamole.
7. To be familiar with the mechanism of action of some antiplatelet agents under investigation including von Willebrand factor monoclonal antibody, aurintricarboxylic acid, glycoprotein IIb/IIIa receptor antagonists, thromboxane/endoperoxide receptor inhibitors, prostaglandin E1, prostacyclin, proteolytically inactive mutant thrombins, and trapidil.

VI. The Detection of Abnormal Bleeding
1. To understand the relevant historical information in patients with a bleeding disorder.
2. To understand the coagulation studies that should be done routinely and those that should be done when a bleeding disorder is suspected.
3. To understand the importance of spontaneous ecchymosis and petechiae.
4. To understand the specific clinical presentation, genetic transmission and factor deficiency in hemophilia A, hemophilia B and von Willebrand’s disease.
5. To understand the purpose of the bleeding time, the significance and common causes of an abnormal test.
6. To understand how to evaluate the intrinsic coagulation cascade and what drugs and factor deficiencies affect it.
7. To understand the significance of circulating inhibitors such as the lupus anticoagulant.
8. To understand how to evaluate the extrinsic coagulation cascade and what drugs or factor deficiencies affect it.
9. To have a working knowledge of the work-up and management of perioperative bleeding.

VII. The Use of Blood Products for Surgical Bleeding
1. To understand the risks of blood products and why transfusion practices have changed.
2. To understand the indications for red cell transfusions including a knowledge of the myocardial work requirements at hemoglobin levels of <7g/dL, between 8 and 10 g/dL and >10g/dL.
3. To understand the risks of and indications for administration of fresh-frozen plasma and cryoprecipitate.
4. To understand the indications for platelet transfusions in asymptomatic patients, patients who require a surgical procedure, and patients who have spontaneous bleeding.

VIII. Use of Desmopressin (DDAVP) in Vascular Surgery
1. To understand the properties, mechanism of action, and indications for its use.
2. To understand the phenomenon of tachyphylaxis including why it occurs and its significance.

IX. Hypercoagulability Syndromes
1. To understand the significant history, work-up and treatment for antithrombin III deficiency, protein C and S deficiency, factor V (Leiden) mutation [activated protein C resistance].
2. To understand the role of pregnancy and oral contraceptives on thrombosis.
3. To understand the need for thromboembolism prophylaxis in the various acute phase reactions such as trauma or operation.
4. To understand the significance of antiphospholipid antibodies including the types of patients at risk and the management implications.
5. To understand the role of screening in routine patients and high risk patients.
6. To understand the effects of coumadin, heparin and antiplatelet agents on lab measurements for hypercoagulability.
7. To understand the differential diagnosis and management of intraoperative clotting including the management of intimal injury, heparin induced thrombosis or antithrombin III deficiency.

X. Ancrod
1. To understand the derivation, mechanism of action, and uses.
2. To understand its effect on blood viscosity and its possible benefit in patients with arterial ischemia.
3. To understand the differences between the fibrinolytic activity of ancrod as compared to urokinase.
4. To understand the risks of too rapid defibrination.
5. To understand the risks of a lack of fibrin on wound healing.
6. To understand the management of ancrod induced bleeding complications.
20. Diagnosis and Management of Miscellaneous Vasculogenic Problems
Blair A. Keagy, M.D., Mark A. Farber, M.D., Sean D. O’Donnell, M.D., John J. Ricotta, M.D.

I. Anatomy and Pathophysiology

A. Raynaud’s Syndrome
1. To understand the epidemiology and pathophysiology surrounding Raynaud’s Syndrome.
2. To define the epidemiologic parameters involved in Raynaud’s Disease.
3. To define the physiologic mechanism occurring in Raynaud’s Phenomenon.
4. To define the criteria for obstructive Raynaud’s Syndrome.
5. To define the role of adrenergic receptors in the cause of Raynauds.

B. Neurogenic Thoracic Outlet Syndrome
1. To understand the anatomy of the thoracic outlet and the anatomic predisposition to developing TOS, including osseous abnormalities, and soft tissue abnormalities.
2. To understand the association of trauma, both direct and indirect, with the development of TOS.
3. To define the histological changes described in the scalene muscles of patients with TOS.

C. Causalgia/Reflex Sympathetic Dystrophy
1. To understand the pathogenesis of causalgia including that of artificial synapses, and the cycle of reflexes.
2. To define the clinical stages of Drucker, along with their characteristics and symptoms.

D. Vasculogenic Impotence
1. To describe the physiology involving erection including the blood supply, and innervation.
2. To define the differences associated with organic, psychogenic, neurogenic, and vasculogenic impotence.

E. Pediatric Vascular Disorders
1. To define and recognize the various congenital vascular lesions in children.
2. To recognize the problems associated with hemangiomas.
3. To understand renovascular hypertension in the pediatric population.
4. To understand the pathophysiology of renal vein thrombosis.

II. Diagnostic Evaluation

A. Raynaud’s Syndrome
1. To understand the clinical presentation of patients with Raynaud’s Syndrome, and their presenting symptoms.
2. To recognize the associated diseases.
3. To define the appropriate use of laboratory testing in the diagnosis of Raynauds, including the occlusive digital hypothermic challenge test, angiography and plethysmography.

B. Neurogenic Thoracic Outlet Syndrome
1. To define the demographic aspects of patients presenting with TOS.
2. To recognize the symptoms associated with the disease, including pain, parasthesias, and associated symptoms.
3. To recognize the musculoskeletal disorders that mimic TOS.
4. The utilization of diagnostic tests including the Tinel and Phalen test, Adson test, and the arm stress test, and recognize the physical findings suggestive of TOS along with their sensitivity and shortcomings.
5. To understand the role of ancillary diagnostic tests in the work-up of TOS including, but not confined to, chest radiographs.
6. To recognize the need for a complete neurologic examination in these patients.
7. To define the role of electrophysiology studies in the evaluation including ulnar nerve conduction velocities, electromyography, and somatosensory evoked potentials.

C. Causalgia/Reflex Sympathetic Dystrophy
1. To understand the presenting symptoms and differential diagnosis of causalgia.

D. Vasculogenic Impotence
1. To understand the role of non-invasive vascular testing.
2. To understand the role of indirect neurologic testing in impotence.
3. To recognize the usefulness of intracavernous papaverine injection and angiography in the diagnosis of impotence.

E. Pediatric Vascular Disorders
1. To recognize the clinical presentation of renal vein thrombosis in children and its diagnostic evaluation.

III. Treatment
A. Raynaud’s Syndrome
1. To recognize the medications that should be avoided in these patients.
2. To define the use of sympatholytic agents, and their replacement by calcium channel blockers.
3. To recognize the role of new therapies for treatment.

B. Neurogenic Thoracic Outlet Syndrome
1. To identify the role of conservative treatment for TOS.
2. To define the operative treatment of TOS including the choices for operative exposure, role of scalenectomy, concept of total decompression, and rationale for sparing the first rib.
3. To recognize the complications associated with the procedure including nerve, vascular, and lymphatic injuries.

C. Causalgia/Reflex Sympathetic Dystrophy
1. To define the timing of operative therapy for RSD, along with its results.
2. To identify the complications surrounding the procedure and the disease.

D. Vasculogenic Impotence
1. To understand the means of prevention of impotence during surgical procedures of the aorta and the results of appropriate revascularization.
2. To define the risk of impotence with associated vascular procedures.
3. To define the role of revascularization of the penis.

E. Pediatric Vascular Disorders
1. To define the treatment strategies for renal vein thrombosis.
2. To understand the treatment options in children with congenital vascular lesions.

References
21. **Non-Atherosclerotic Vascular Diseases**
William L. Smead, M.D., R. Eugene Zierler, M.D.

**I. Immune Arteritis**
1. To understand the basic pathologic mechanisms of vascular injury in the immune arteritis syndromes.
2. To define a classification system for the vasculitides on the basis of clinical findings, pathology, and prognosis in a way that assists in the diagnosis and management of these patients, recognizing the considerable overlap that exists among these diseases. This classification system would include the systemic necrotizing vasculitides, the hypersensitivity vasculitides, giant cell arteritis, and a diverse miscellaneous group.
3. To recognize the clinical problems which should alert the physician to consider a systemic vasculitis, particularly ischemic symptoms involving multiple organ systems in patients under 55 years of age, involving organs and limbs in distributions not typical for atherosclerosis, and occurring at an unusually accelerated pace.
4. To understand the basic clinical laboratory tests useful in the diagnosis and management of vasculitis. Diagnostic tests range from routine evaluations to more specific tests for defining the immunophysiology. Management requires testing to define the current inflammatory status as well as specific measurements of organ function.
5. To understand the role of arteriography and the characteristic findings in the arteritis syndromes of surgical significance.
6. To recognize the role of tissue biopsy in establishing a firm diagnosis.
7. To recognize the clinical presentation of polyarteritis nodosa, the laboratory and pathologic features of the disease which establish the diagnosis, and the complications of the disease with surgical significance.
8. To be familiar with the small vessel complications of hypersensitivity angiitis, a large category of vasculitides with a wide variety of etiologies including infection, drug and chemical allergies, connective tissue diseases, neoplasm, Henoch-Schönlein purpura, serum sickness, cryoglobulinemia, and a large miscellaneous category represented by chronic active hepatitis, primary biliary cirrhosis, inflammatory bowel disease, and intestinal bypass surgery. To understand the medical and surgical management of ischemic complications of these disorders.
9. To recognize the giant cell arteritis group of diseases which includes temporal arteritis and Takayasu-Onishi disease. To understand the distinctive arteriographic patterns of these disorders and the medical and surgical treatment strategies.
10. To be familiar with the miscellaneous vasculitis syndromes of surgical significance, including Kawasaki’s syndrome, Behcet’s disease, Cogan’s syndrome, and Buerger’s disease.

**II. Fibromuscular Dysplasia**
1. To understand the pathologic classification of fibromuscular dysplasia: intimal fibroplasia, medial fibroplasia, medial hyperplasia, and perimedial dysplasia.
2. To recognize the vascular beds most frequently affected by this disorder (renal, cerebrovascular, mesenteric, and aortoiliac arteries) and the symptoms with which patients most frequently present.
3. To recognize the arteriographic patterns distinguishing each of the types of fibromuscular disease from each other and atherosclerosis.
4. To understand the natural history of fibromuscular disease in its various locations and its impact on clinical decision making.
5. To understand the various treatment options available including endovascular techniques and surgical bypass.

**III. Adventitial Cystic Disease**
1. To understand this rare condition producing arterial stenosis or occlusion in young patients, its clinical presentation, arteriographic features, operative findings, and management options.

IV. Popliteal Intrapment Syndromes
1. To understand the clinical presentation of this congenital anomaly predominantly affecting young men, its characteristic noninvasive vascular laboratory and arteriographic findings (provocative testing), and the available treatment alternatives.
2. To be familiar with the various anatomic variants which produce the abnormal relationship between the popliteal artery and the medial head of the gastrocnemius muscle.
3. To recognize the characteristic findings suggesting the adductor canal syndrome in which the junction of the superficial femoral and popliteal arteries is compressed by the tendinous insertion of the adductor magnus muscle at Hunter’s canal.

V. Compartment Syndromes
1. To understand the multiple etiologies of compartment syndromes which have in common the production of sufficient compartmental pressure to compromise blood flow to the tissues within it, conditions which decrease compartmental volume or increase compartmental content or provide excessive external pressure.
2. To recognize those clinical situations in which compartment syndrome is more likely to develop complicating vascular injury or disease: prolonged ischemia, coexistent shock, preoperative neurologic deficits, pre- or intraoperative edema, combined arterial and venous injury, or concomitant crush injury.
3. To recognize the symptoms and signs of elevated compartment pressure and the tests available to confirm the diagnosis.
4. To understand the indications for fasciotomy and the surgical techniques available.
5. To understand the medical management of established rhabdomyolysis.

VI. Congenital Arterial Conditions
1. To be familiar with the various types of abdominal coarctations and their clinical presentations and natural history.
2. To understand the role of arteriography in the diagnosis of the problem and the planning of surgical treatment of abdominal coarctation.
3. To be familiar with the surgical options for repair and renal revascularization in patients with abdominal coarctation.
4. To recognize the arteriographic findings in patients with a persistent sciatic artery and the potential surgical implications.

VII. Diseases of the Arterial Media
1. To understand the pathologic changes of cystic medial necrosis which result in the clinical problems of aortic dissection, spontaneous rupture, and aneurysm formation.
2. To recognize the classic abnormalities associated with Marfan’s syndrome and the typical cardiovascular complications.
3. To understand the natural history of Marfan’s syndrome and the management options available to treat these cardiovascular problems.
4. To recognize the characteristic abnormalities in patients with Ehlers-Danlos syndrome and the issues of surgical significance including aneurysm formation, dissection, and spontaneous rupture.
5. To be familiar with the vascular changes in patients with pseudoxanthoma elasticum, arterial stenosis/occlusion and hypertension.
6. To recognize the changes associated with arteria magna syndrome and the role of arteriography in diagnosis, treatment, and patient follow-up.
VIII. Errors in Homocysteine Metabolism
1. To understand the inborn error of metabolism that produces homocysteinuria and the associated multiple abnormalities including mental retardation, lens ectopia, rapidly progressive premature atherosclerosis, and thromboembolic disorders.
2. To be familiar with the heterozygous trait which results in homocysteinemia and premature atherosclerosis, potentially ameliorated by treatment with folic acid, pyridoxine, and vitamin B₁₂.

IX. Hyperviscosity Syndromes
1. To understand the myeloproliferative disorders and serum protein abnormalities that result in arterial or venous thromboembolism.

X. Arterial Infections
1. To recognize the symptoms and signs of arterial infections and the most common responsible pathogens.
2. To understand the etiologies of arterial infection including bacterial endocarditis, mycotic or infected aneurysms, drug abuse, iatrogenic contamination, and contiguity to adjacent infection.
3. To recognize the most effective techniques for obtaining positive cultures on which to base antibiotic treatment in patients with arterial infections.
4. To be familiar with the principles and treatment strategies for the management of arterial infection.

XI. Vasospastic Disorders
1. To understand the classification of cold sensitivity of the Raynaud type (Raynaud’s disease and Raynaud’s phenomenon).
2. To recognize the common clinical presentations of vasospasm due to cold sensitivity.
3. To be familiar with the noninvasive diagnostic evaluation of digital ischemia and vasospasm.
4. To understand the features of uncommon vasospastic disorders, including livedo reticularis, acrocyanosis, and erythromelalgia.
5. To be familiar with the various treatment approaches to primary and secondary vasospasm.

References
22. **Arteriovenous Malformations and Arteriovenous Fistulae**
Michael A. Golden, M.D., James C. Stanley, M.D., Thomas C. Naslund, M.D.

I. **Anatomy and Pathophysiology**
1. To understand the pathophysiology of arteriovenous malformations (AVM) and arteriovenous fistulae (AVF). This includes the rare forms (congenital and acquired) and the more common forms (traumatic and iatrogenic) of arteriovenous communications.
2. To define the influences of age, location, presenting symptoms and past medical, surgical and traumatic history on the etiology of arteriovenous communications, and to recognize the importance of syndromes with AVM.
3. To understand the common risk factors for the development of acquired arteriovenous communications, and how to anticipate and minimize the risks.
4. To understand the clinical settings associated with congenital AVM and to recognize them without delay.
5. To understand the early and the late important hemodynamic properties and effects of arteriovenous communications, and the effects of these changes on perfusion.
6. To understand the adaptive responses to the abnormal hemodynamics associated with arteriovenous communications.
7. To understand the natural history of arteriovenous communications as a function of the type of communication, (etiology, location, size, comorbidity and complications).
8. To understand the principles for the creation of arteriovenous communications for therapeutic indications, such as dialysis access, and distal extremity bypass grafts and venous bypass grafts.
9. To understand the technical considerations for the creation of arteriovenous communications for therapeutic indications, such as dialysis access, and distal extremity bypass grafts and venous bypass grafts.
10. To understand the complications and problems with therapeutic arteriovenous communications.

II. **Diagnostic Evaluation**
1. To understand the patterns of presentation of patients with arteriovenous malformations (AVM) and arteriovenous fistulae (AVF). This includes the rare forms (congenital and acquired) and the more common forms (traumatic and iatrogenic) of arteriovenous communications.
2. To understand the role of history and physical examination in the diagnosis of arteriovenous communications.
3. To define appropriate, cost effective diagnostic testing for arteriovenous communications.
4. To understand the role of the vascular diagnostic laboratory for the diagnostic evaluation of arteriovenous communications.
5. To understand the role of magnetic resonance imaging and magnetic resonance angiography for the diagnostic evaluation of arteriovenous communications.
6. To understand the role of contrast angiography for the diagnostic evaluation of arteriovenous communications.
7. To understand the role of diagnostic studies for the selection of the patient and site, and the preparation for the creation of a therapeutic arteriovenous communication.
8. To understand the diagnostic evaluation of the complications and problems with therapeutic arteriovenous communications.

III. **Treatment**
1. To understand the role of conservative management for arteriovenous communications.
2. To understand the role of catheter based intervention in the treatment of arteriovenous communications.
3. To understand the role of open surgery in the treatment of arteriovenous communications.
4. To understand the interactions of the treatments and the expected impact of combinations of treatments of
arteriovenous communications.
5. To understand the principles for the creation of arteriovenous communications for therapeutic indications, such as dialysis access, and distal extremity bypass grafts and venous bypass grafts.
6. To understand the technical considerations for creation of arteriovenous communications, for therapeutic indications, such as dialysis access, and distal extremity bypass grafts and venous bypass grafts.
7. To understand the complications and problems with therapeutic arteriovenous communications.
8. To understand the advantages and disadvantages of therapeutic AVF.

References
23. **Vascular Access**
Mitchell H. Goldman, M.D., Enrico Ascer, M.D., Gary Peterson, M.D.

I. Anatomy and Pathophysiology
1. To know that arterial and venous anatomy involved in the commonly placed grafts and sited for hemodialysis in the upper and lower extremities; know the options for unusual graft sites when extremities are not available.
2. To know the local and systemic, anatomic effects of creating an arteriovenous fistula for the purpose of hemodialysis.
3. To know the anatomic landmarks for the various routes of access to the circulation for the use of chemotherapy, chronic infusion, obtaining blood samples, and physiologic monitoring.
4. To know the hemodynamic and physiologic effects of creating an arteriovenous fistula; understand the effects of large and small fistulae on the adjacent arteries and veins and on the body as a whole.
5. To know the anatomic and physiologic etiologies for arterial steal, decreased extremity flow and venous hypertension in AV fistulas created for hemodialysis.

II. Diagnostic Evaluation
1. To know the physical exam and diagnostic tests used in selecting a site for a vascular access including Allen’s test, use of duplex screening of veins, and stereograpy.
2. To know the diagnostic tests used in evaluating an arteriovenous access with high resistance, poor pressure, thrombosis, and infection.
3. To know the complications of obtaining access to the central circulation and the diagnostic examinations and tests used to diagnose pneumothorax, misplaced line, pseudoaneurysm, venous thrombosis, and hemorrhage.
4. To know the use of duplex scanning in the evaluation of AV accesses.

III. Treatment
1. To know the uses and benefits of using autologous or synthetic grafts for the purpose of hemodialysis including the locations, timing of placement, maturation of and longevity of the various access routes and grafts.
2. To know the treatment of complications of arteriovenous fistulas for hemodialysis including infection, steal syndrome, aneurysms, venous hypertension, thrombosis, stenosis, and the failing graft.
3. To know the use of revision, patching, extending, banding, angioplasty and stenting as methods of prolonging AV access.
4. To know the advantages, techniques and commensurate applications of each route of access to the circulation for the use of administering chemotherapy, chronic infusions, obtaining blood samples and hemodynamic monitoring.
5. To know the complications of the above routes and their treatment.
6. To know the catheter types, their advantages, available for gaining access to the circulation.
7. To know the long term outcome and patencies of the various access types.

References
3. Rivers SP, Scher LA, Veith FJ. Correction of steal syndrome secondary to hemodialysis access fistulas: a
24. **Sympathectomy**
Thomas S. Riles, M.D.

I. Anatomy and Physiology
1. To understand the basic anatomy of the autonomic nervous system including the course of sympathetic fibers through the spinal cord, the location of the sympathetic ganglia an the course of the post synaptic fibers.
2. To understand the relationship between the sympathetic fibers and the abdominal aorta and iliac vessels.
3. To understand the functions of the sympathetic nervous system and the pathologic conditions resulting from abnormal sympathetic activity.
4. To understand the potential beneficial effects of sympathetic ablation and possible adverse side effects.

II. Diagnostic Tests to Evaluate Sympathetic Function
1. To understand the basis of various tests to assess sympathetic activity.
2. To be aware of the limitations of the diagnostic tests used to assess sympathetic activity.

III. Clinical Uses of Sympathectomy
1. To understand the historic and current role of sympathectomy for arterial occlusive disease.
2. To understand the probable outcome when sympathectomy is used for ischemic ulcers, gangrene, rest pain, and the differences in clinical response for diabetes and non-diabetes.
3. To be aware of the role of sympathectomy for Buerger’s disease, embolic disease, Raynaud’s phenomenon, causalgia and post traumatic rest pain, and hyperhidrosis.

IV. Surgical Technique
1. To be aware of the technique for surgical ablation of the lumbar sympathetic chain as well as the technique for chemical ablation.
2. To be aware of the surgical technique for thoracodorsal sympathectomy.
3. To understand the potential complications from lumbar and thoracoabdominal sympathectomies and how to reduce the risk of complication.

References


II. Etiology
1. Describe intrahepatic and extrahepatic (pre- and posthepatic) causes of obstruction to the portal circulation.
2. Understand the causes of portal hypertension which are extrahepatic, intrahepatic, sinusoidal and hepatic venous in etiology. Categorize portal vein thrombosis, schistosomiasis, cirrhosis, and Budd-Chiari syndrome in this classification.
3. Understand and define the determinants of variceal bleeding.

III. Diagnostic Evaluation
1. Define the Child’s classification
2. Understand the clinical evaluation of the portal hypertensive patient and describe the stigmata of liver disease detailed during a history and physical examination.
3. Describe the importance of liver function studies in the Child’s classification.
4. Understand angiographic imaging of the portal vein by selective splanchnic angiography. Alternative techniques including computed tomography and magnetic resonance imaging may also contribute and should be understood in the evaluation of these patients.
5. Describe the role for hemodynamic measurements including wedge hepatic venous pressure as well as duplex imaging of the portal vein.

IV. Management
1. Control of acute variceal bleeding.
   a. Understand the circumstances of variceal bleeding, its mortality in relationship to the Child’s classification, and the natural history of bleeding.
   b. Understand the role of fluid management, pharmacological treatment with splanchnic vasoconstrictors (vasopressin), vasodilators (nitroglycerin) and other pharmacologic agents.
   c. Understand the role of the Sengstaken-Blakemore and Linton tubes in the control of acute variceal bleeding.
   d. Describe the value of endoscopic sclerotherapy in the management of acute variceal bleeding. Understand the efficacy and timing as well as the technique used for endoscopic injection.
   e. Describe endoscopic variceal band ligation and percutaneous transhepatic embolization in the control of variceal bleeding.
2. Surgical Management of Portal Hypertension
a. Understand the historical development of the Eck fistula and its impact on the surgical management of portal hypertension.

b. Understand the difference between total portal-systemic shunts and selective (distal splenorenal) shunts.

c. Describe the non-shunt surgical management of varices including the Womack and Sugiura procedures.

d. Describe the development and use of intrahepatic shunts (transjugular intrahepatic portosystemic shunts-TIPS).

e. Describe the advantages of the TIPS procedure for acute variceal bleeding and the anticipated mortality when compared with portal-systemic shunts.

f. Understand the role of liver transplantation in patients with portal hypertension and variceal bleeding.

V. Describe a current clinical algorithm for the management of variceal hemorrhage.

a. Understand the role of early endoscopic diagnosis in the control of variceal bleeding.

b. Understand that endoscopic sclerotherapy will control the majority of patients with acute variceal bleeding, while balloon tamponade or TIPS may be required in the remainder of patients.

c. Understand options for non-alcoholic and alcoholic patients with controlled or recurrent bleeding: selective variceal decompression with distal splenorenal shunt, sclerotherapy with or without pharmacological agents, and liver transplantation.

References


